FLAG FEN, PETERBOROUGH

EXCAVATION AND RESEARCH 1995–2007

Edited by

Francis Pryor and Michael Bamforth

FLAG FEN, PETERBOROUGH

EXCAVATION AND RESEARCH

1995–2007

FLAG FEN, PETERBOROUGH

EXCAVATION AND RESEARCH
1995–2007

Edited by

Francis Pryor and Michael Bamforth

With principal contributions by

Michael Bamforth, David Britchfield, Marcus Brittain, Elizabeth Henton, Jill Hooper, Francis Pryor and Maisie Taylor

Oxbow Books
Oxford and Oakville

Published by
Oxbow Books, Oxford, UK

ISBN 978 1 84217 414 2

A CIP record for this book is available from the British Library

This book is available direct from

Oxbow Books, Oxford, UK
(Phone: 01865–241249; Fax: 01865–794449)

and

The David Brown Book Company
PO Box 511, Oakville, CT 06779, USA
(Phone: 860–945–9329; Fax: 860–945–9468)

or from our website

www.oxbowbooks.com

Library of Congress Cataloging-in-Publication Data

Excavation and research at Flag Fen, Peterborough, 1995-2007 / Edited by Francis Pryor and Michael Bamforth , with principal contributions by Michael Bamforth...[et.al.].
p. cm.
Includes bibliographical references.
ISBN 978-1-84217-414-2
1. Flag Fen Site (England) 2. Bronze age--England--Fens, The. 3. Neolithic period--England--Fens, The. 4. Water-saturated sites--England--Fens, The. 5. Excavations (Archaeology)--England--Fens, The. 6. Fens, The (England)--Antiquities. I. Pryor, Francis. II. Bamforth, Michael.
GN778.22.G7E97 2010
936.2'651--dc22
2010012743

Printed and bound by
Short Run Press, Exeter

Dedication

For Chris Evans, Mark Knight, Ben Robinson
and everyone who takes research
of this unique landscape into the future.

Contents

List of Figures

Contributors

Michael Bamforth
L – P : Archaeology
The Old Truman Brewery
91 Brick Lane
London
E1 6QL
m.bamforth@lparchaeology.com

Dot Boughton
Finds Liaison Officer (Lancs./Cumbria)
Museum of Lancashire
Preston
PR1 4YP
dot.boughton@lancashire.gov.uk

David Britchfield
Freelance Archaeologist
54 High Street
Wouldham
Rochester
Kent
ME1 3UT
david.britchfield@hotmail.co.uk

Marcus Brittain
Cambridge Archaeological Unit
34a Storeys Way
Cambridge
Cambridgeshire
CB3 0DT
mb654@cam.ac.uk

David Buckley
69 Vicarage Road
Chelmsford
Essex
CM2 9BT
dbuckley@btinternet.com

Lys Drewett
lysdrewett@btinternet.com

Lavinia Ferrante di Ruffano
lavinia.ferrante@gmail.com
l.ferrantediruffalo@bham.ac.uk

Elizabeth Henton
Institute of Archaeology
University College London
31–34 Gordon Square
London
WC1H 0PY
e.henton@ucl.ac.uk

Jill Hooper
Freelance Archaeologist
pdsdive@hotmail.com

Paul Middleton
The Diocesan Office
The Palace
Peterborough
PE1 1YB

Francis Pryor
Flag Fen Bronze Age Centre
The Droveway
Northey Road
Peterborough
PE6 7QJ

Alison Sheridan
Archaeology Department
National Museums Scotland
Chambers Street
Edinburgh
EH1 1JF

Maisie Taylor
Flag Fen Bronze Age Centre
The Droveway
Northey Road
Peterborough
PE6 7QJ

Illustrations by: **Chloe Watson** and **Maisie Taylor**
Figures produced by: **Andrew Dufton** and **Sophia Stouki**, L – P : Archaeology

Acknowledgements

The following wish to record their individual acknowledgements:

Francis Pryor
I would first like to thank all the contributors who worked so hard for so little financial reward. This was never a wealthy project! I would also like to thank their various employers, who turned many blind eyes to their not-so-clandestine labours. Most particularly I wish to thank L – P : Archaeology for all the help and support they offered, and my co-editor Michael Bamforth, who managed the final stages of the production process before the manuscript and disks were sent to Oxbow – who in turn must also be acknowledged for their help and support. It has not been an easy task to knit together so many disparate projects and I am particularly grateful to my old friend and colleague Dr Charly French, at Cambridge University, who read the final draft of the manuscript and made a large number of detailed comments which have done much to provide academic cohesion. Errors are of course the editors' responsibility alone.

Michael Bamforth
I am very grateful to Amy Sutton, who carried out a huge amount of data entry to help bring the wood database up to date; Mark Linane, who volunteered his time to contribute to the GIS model of the site which was designed by Andrew Dufton; and Lisa Grey, who carried out species identification for the 2005 wood assemblage. The staff of Flag Fen have always been extremely supportive and helpful and I would particularly like to thank Richard Gray for his invaluable assistance with the archive material. Thanks are due to all at L – P : Archaeology for the time and resources to carry out this project, and particularly to Sophia Stouki for her incredibly hard work. I am also grateful to my fellow authors for their patience with me while ironing out the last drafts of the text. Finally, I would like to thank Maisie Taylor for her constant and unwavering tutelage, without which I would not be writing these words.

Maisie Taylor
Special thanks are due to Richard Darrah for initial help with learning about splitting timber and encouraging us to do it ourselves; he was extraordinarily generous with his time, knowledge and experience. For a full account of splitting a big tree, both radially and tangentially, see Richard Darrah (2006, 118–21). Finally, my thanks to Francis Pryor who has had to discuss the subject of monumental timber frequently and at some length.

Marcus Brittain
I would like to convey my appreciation to those who have taken the time to discuss the broader context of Flag Fen and its preservation and potential, and allow access to many a library of unpublished resources. The following deserve particular mention: Michael Bamforth, Steve Boreham, David Britchfield, Christopher Evans, Charly French (who offered invaluable critique of various chapter drafts), David Gibson, Mark Knight, Francis Pryor, Ben Robinson and Maisie Taylor. Toby Fox's support as General Manager during the excavation seasons of 2004 and 2005 is gratefully acknowledged, and the most sincere of thanks must go to all the students and volunteers who lent their time and enthusiasm to those projects. Alice Choyke disclosed various useful sources for European Bronze Age antler cheekpieces, and unpublished photographs and drawings of recent finds were kindly provided by Jonathan Seaman and Carol Allen. Finally, special thanks are reserved for Lavinia Ferrante di Ruffano, not only for her co-direction of excavations in 2004 and 2005, but also for her support and friendship, from which catalysed many of the ideas expressed in Chapters 1 and 2; but of course I willingly bear full responsibility for any final errors or oversights.

Elizabeth Henton
This paper is based on my MSc dissertation and is written with the permission of the Institute of Archaeology, University College London. I would like to thank Dr Louise Martin for her supervision and support, the Flag Fen Project and Peterborough Museum for allowing me to use their archive material, and the Natural History Museum and the Chillingham Wild Cattle Reserve for the modern baseline material.

Jill Hooper
I would like to thank Elizabeth Henton for her help identifing the bone assemblages, the Institute of Archaeology, University College London, for allowing me to use their bone collection for identification, and a special thanks to Lavinia Ferrante di Ruffano for her encouragement and support.

Preface

When I began the Fengate Project back in 1971 I had no idea that I would still be writing about the archaeology of the Peterborough fen margins nearly 40 years later. The original project ended in 1995 and since then the work has been funded almost entirely by Anglian Water. Not only did they provide us with regular annual income to support our research, but they gave us access to their land and other useful facilities. Perhaps most importantly a series of their senior managers and other staff have contributed to the deliberations of the Council of Fenland Archaeological Trust where their knowledge, advice and forethought has proved invaluable. This report is written in gratitude, as a tribute to their quiet and persistent support for so many years.

Professor Francis Pryor MBE, PhD, FSA, MIFA
Director of Archaeology
Fenland Archaeological Trust

anglianwater

Introduction: Excavation and Research at Flag Fen after the Main Campaign of 1982–94

Francis Pryor

The site, the landscape and continuing research

The Flag Fen basin is an area of low-lying land on the northern side of the River Nene's natural outfall into the larger Fenland basin, of which it forms a part (Fig. 0.1). To the east lies the slightly higher ground of Whittlesey 'island', and extending west from this 'island' is a low promontory known today as Northey. The northern side of the Flag Fen basin is formed by the higher land of Fengate, while to the south the basin is confined by a slight rise in the underlying geology in the area immediately east of Whittlesey comprising Bradley Fen, King's Dyke and Horsey Toll. Today much of this land has been quarried away by deep brick pits, but sufficient survives to show that archaeological preservation is excellent in the undisturbed areas. This is where teams from the Cambridge Archaeological Unit are currently making prehistoric discoveries of the greatest importance.

The precise date when the Flag Fen basin started to become waterlogged is not entirely certain and will most probably have varied from one place to another, depending on local drainage conditions. The underlying process is, however, quite clear. The general post-glacial rise in sea levels led to the flooding of 'Doggerland' and the southern North Sea basin (Shennan 1982; Gaffney *et al*. 2007). It appears probable that peats began to form in

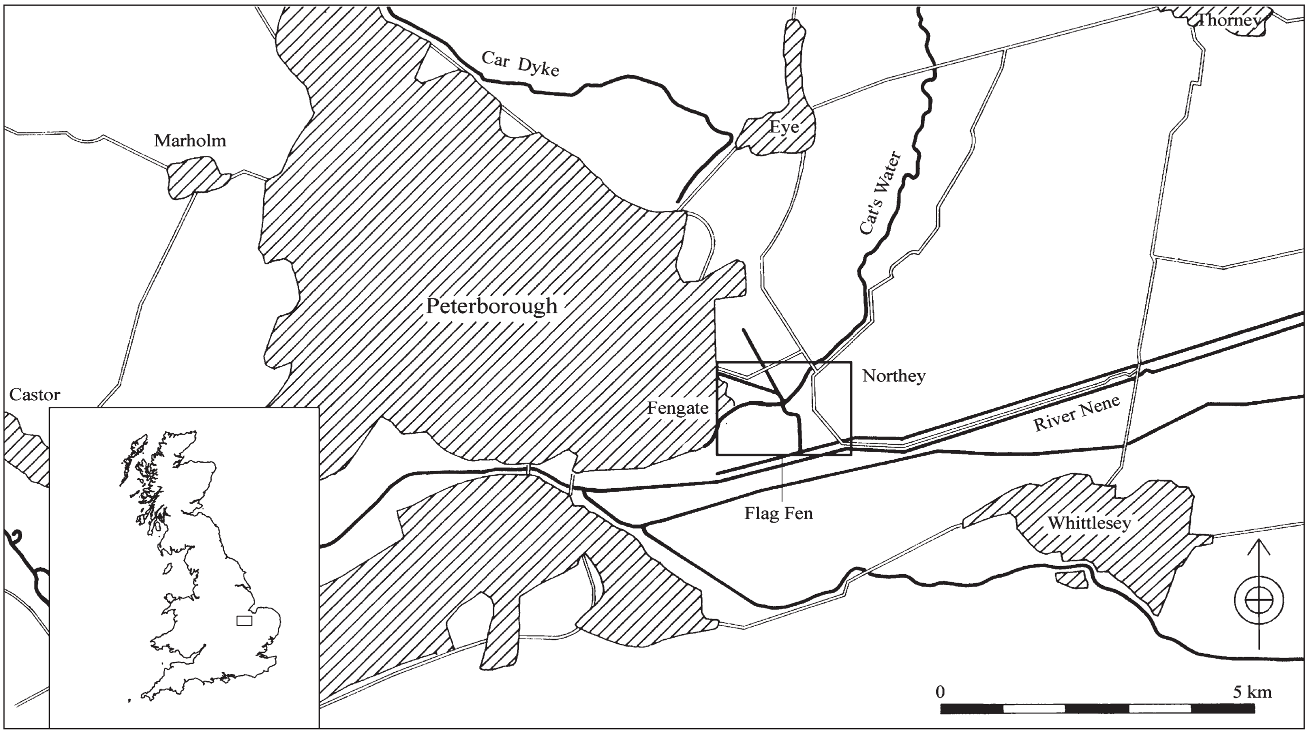


Figure 0.1. Location of Flag Fen (after Pryor 2001, Figure 1.1, p.1)

the deeper parts of the Flag Fen basin (in the region of the post alignment, if not in the southern area around Bradley Fen and Horsey Toll currently being investigated by the Cambridge Archaeological Unit) sometime around and just after 2000 cal BC (Scaife 2001, 367). Water levels then continued to rise and became slightly more saline in the later Bronze Age, from about 1300 BC, when there is evidence for salt-extraction briquetage at Fengate and Northey (Pryor 1980, 19; Gurney 1980). Although Late Bronze Age and Iron Age communities paid regular visits there, the timbers of the post alignment ceased to be maintained from around 900 BC, when Flag Fen became flooded. This flooding persisted throughout the Iron Age and affected not just the Flag Fen basin but large areas of Fenland too (Waller 1994, 76–7).

It would now appear that the drier soils around the very edges of the regularly flooded land within the Flag Fen basin were rather more variable than we believed in the 1970s. Clays and poorly draining soils occur in patches within the gravels, especially along the southern margins. This indicates that the flood-free fen-edge landscapes were varied and heterogeneous, to such an extent that smaller sub-basins or embayments may soon be defined thanks to improvements in survey technology and the introduction of new prospection methods such as LIDAR (light detection and ranging).

The growing awareness of the complexity of evolving prehistoric environments and our observations of cultural responses to these changes will contribute to a greater practical and theoretical understanding of the relationship between prehistoric communities and their surroundings. These relationships are unlikely to be readily predictable and will doubtless provide surprises, which is why it is so important that areas as well-preserved as the Flag Fen basin continue actively to be studied, even if contract or rescue projects have to be cancelled for non-archaeological reasons. Put simply, the research is far too important to be left to the whim of commercial developers alone. Furthermore, multi-disciplinary research cannot be hurried, as it necessarily involves a number of different specialists; consequently full advantage should be taken of the greater time that a prolonged slow-down in the economy of the early 21st century might provide.

Preservation and continuing deterioration

A succession of hot summers and dry winters in the last three decades of the 20th century made it only too apparent that the soils of Flag Fen were drying out. The situation was further complicated by other factors. For instance, the site was used regularly for the spreading of sewage waste and part of this process involved allowing the sludge to dry out over summer prior to incorporation into the topsoil in the autumn; later, this process was replaced by direct injection into the soil (which involved the use of large

Fig. 0.2. Principal archaeological and landscape features

powerful tractors). The deepening and enlargement of the Mustdyke/Padholme Drain in 1982 (Fig. 0.2), which led directly to the discovery of the first timbers, has undoubtedly had an effect on water levels in the surrounding land. Similarly, the recognition that the Mustdyke/Padholme Drain proves the principal flood-relief channel for the Eastern Industrial Area (comprising all of Fengate and the land on either side of Padholme Road) has led to its substantial enlargement to form, in effect, a flood-relief storage area or reservoir – with long-term consequences for as yet unknown buried archaeological deposits in its environs. There have also been a number of commercial development proposals for the area and these might have a detrimental effect on an already perilously low water table, despite optimistic environmental impact assessment statements usually prepared by hydrologists with little experience of archaeological problems, where the smallest of changes can have disastrous long-term consequences (see, for example, French and Taylor 1985).

As a response to this challenging situation the Fenland Archaeological Trust sought funds from English Heritage for a project that monitored the fluctuations of the ground water table towards the Fengate 'shore' of Flag Fen. The work was carried out by subcontractors between February and April 2002 and the results have been published in full (Lillie and Cheetham 2002; Lillie 2007). Meanwhile, further research was being carried out closer to the platform, towards the Northey fen-edge. All these projects, as well as fresh research and new conclusions, are discussed by Marcus Brittain in Chapter 1.

Excavation and survey

The waterlogged deposits at Flag Fen are drying out and Peterborough is continuing to grow and develop as a successful city. These were the principal imperatives behind the excavations and surveys that followed on from the main, largely English Heritage-funded, campaigns of 1982–94. These projects were primarily focused along the western post alignment between the main platform excavations and the Power Station. A full listing of the investigations carried out since 1995 is included as Appendix 1. While this work was going on, the Trust's contract arm, Soke Archaeological Services Ltd, was conducting pre-development assessment of the land required by Anglian Water for the construction of several phases of enlargement to the Flag Fen Sewage Treatment Works. Both projects are described by Marcus Brittain in Chapter 2.

Flag Fen is continuing to develop as an attraction and it was clear from the mid-1990s that it required a new and larger visitor centre and, with it, more propitious access – away from the scrap yards of the city's Eastern Industrial Area. It was fully anticipated that any earthmoving in the Flag Fen basin would inevitably encounter archaeological remains; this was to prove the case, despite our best efforts to position the new facilities away from deeply waterlogged ground.

Another project loosely associated with tourism was the filming for three days in 1999 of an episode of Channel 4's television series *Time Team*. This work was linked to the provision of the new Northey Road access and the construction of the Green Wheel cycleway (a Millennium Commission Project). At the time it had also become quite clear that a flattened round barrow in agricultural land in the field opposite the new access was being repeatedly deep-ploughed and was undoubtedly suffering as a result.

It was decided that the *Time Team* project should include an assessment of what proved to be an earlier Bronze Age barrow with significant later Bronze Age secondary use. The excavations that took place in advance of the building of the New Visitor Centre, access road and Green Wheel cycleway, together with a summary of the *Time Team* trenches, are considered by David Britchfield in Chapter 3.

In January 2000 the buildings at Flag Fen where post-excavation research was taking place were burned to the ground. This fire destroyed the entire slide archive together with records that included pencil original (but not ink duplicate) plans and context sheets. By this time, however, much of the Flag Fen database was in a digital format and up-to-date back-up copies were routinely retained and stored in an electronically separate environment. Despite these precautions, much of the material that was then being actively studied was either damaged or destroyed. The impact of the fire is considered further in Chapter 4.

Finally, it should be noted that although the Flag Fen Basin volume of 2001 contained a series of discussions of recent contract excavations (Pryor 2001, 6–52), the scale and extent of such work has increased hugely over the past decade. It would be impossible to do justice to this in the present volume, but fortunately a full summary has recently been most ably provided by Chris Evans and the team at the Cambridge Archaeological Unit (Evans *et al.* 2009).

Further research into wood and woodworking

Little did we realise, when in 1973 we revealed the base of a Bronze Age notched log ladder in pit W17 of the Storey's Bar Road sub-site at Fengate (Pryor 1978, 39–44), that today we could point to nearly a dozen English parallels for what was then a unique find. Such has been the gathering pace of research into prehistoric carpentry, coppice- and woodworking. Much of the new research has been carried out by Maisie Taylor, latterly with the support and assistance of Michael Bamforth. Although the pace of wood extraction at Flag Fen itself has slowed down in line with the scale of excavation, the quantity and variety of wood from other sites in the Fens and elsewhere has been steadily increasing, as commercial and other developments have gathered pace. Much of this work has taken place ahead of road and pipeline construction, both of which are likely to remain largely unaffected by the approaching economic recession. This wealth of new information has caused Michael and

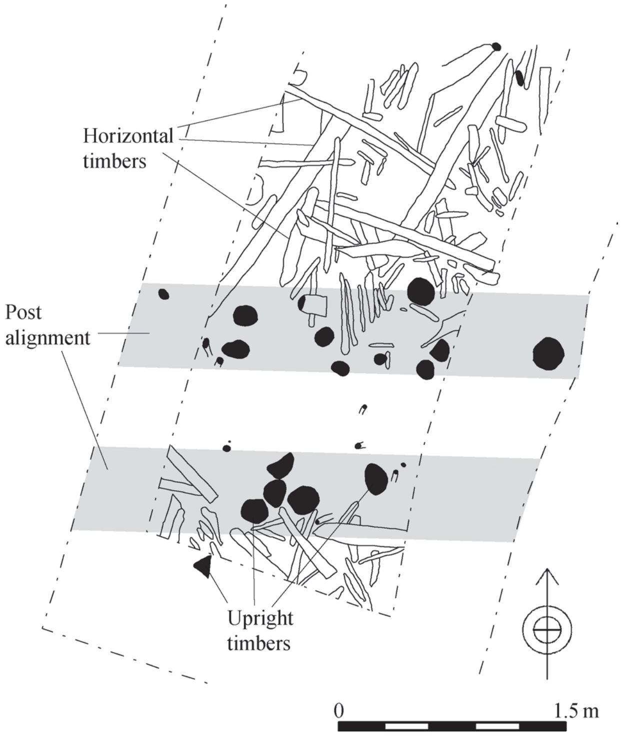


Fig. 0.3. Drawing conventions for timber plans

Maisie to take a fresh look at the wood from Flag Fen and their thoughts are recorded in Chapters 4 and 5. Please note that throughout this volume plans of the woodrn remains are shown with upright timbers shaded in black and post alignment rows shaded in grey (Fig. 0.3).

It should also be recorded here that Flag Fen was an early example of an electronic database that contained the wood, pottery, flints and other finds. Of these, the wood was by far the largest element. Maisie Taylor, who designed the Flag Fen wood database, also entered wood from other sites she examined in the region on comparable databases. The best-known of these was the Holme-next-the-Sea timber circle (widely dubbed 'Seahenge') in Norfolk (Brennand and Taylor 2003). At the time of writing, the relatively small Holme database is in the process of being made accessible on the Internet, and when that has been completed and tested through use, it is planned to extend the online wood database to incorporate other sites, including Flag Fen.

1. Preservation and Degradation of the Wood

Marcus Brittain

Introduction

Since the discovery of waterlogged timbers at Flag Fen over twenty-five years ago, the integrity of the preservation environment has been a serious issue of long-term sustainability. Various rates of change have been observed in both the preservation context and the structural quality of the organic archaeological remains. More recently an accelerated rate of degradation is believed to have had a significant and detrimental effect on the remaining organic record at Flag Fen, heightening the necessity for a controlled programme of action.

A number of monitoring procedures have been implemented since the late 1990s to assess microbial activity, groundwater pH and fluctuations of the water table along the post alignment and platform within the basin. Small-scale research and commercial evaluations have further highlighted the deteriorating condition of the saturated organic remains. While a number of these results have been published individually, they have yet to be discussed together as a composite programme of investigation.

This chapter aims to present a broad summary of these results, in addition to a reflection on previous statements regarding the preservation environment at Flag Fen. When placed in the broader context of the preservation of waterlogged archaeological remains, the implications of the monitoring and observational analysis at Flag Fen pose a number of questions regarding the site's long-term strategy of preservation.

Preservation and degradation of waterlogged archaeological remains

The eastern Fenlands were once the largest wetland in Britain, but with the advent of drainage in the seventeenth century, have now been entirely drained of surface water (Summers 1976; Darby 1983). However, the basal peat of the Flag Fen basin has remained a wet environment in which a fluctuating groundwater table is elevated above a thin layer of Pleistocene clay-capped gravels (Pryor 2001, 3). The primary stages of peat formation coincided with a rise in the water table during the earliest use of the post alignment (Scaife 2001), gradually creating a saturated environment where oxygen has largely been excluded from the lowest layers. The exceptional preservation of organic remains is attributable to this anaerobic context, which is unsuitable for the survival of organisms that would normally consume humic organic material (Taylor 1981).

The constituent substances and sensitivity of peat are highly variable (Clymo 1983), and peat growth is dependent on a number of autogenic (internal) and allogenic (external) factors (Charman 2002). Archaeological preservation, therefore, is the result not of a static environment, but of one that is sensitive and dynamic, the maintenance of which is dependent on soil characteristics, hydrogeological dynamics (including precipitation, evapo-transpiration, run-off and drainage), land use, climate and the nature of the archaeology itself, *i.e.* material type and its use in the past (Van de Noort *et al.* 1995, 341). The preservation of waterlogged organic materials in environments which maintain a course of dynamic morphological change is, therefore, an imperfect process.

Changes in the burial conditions of the archaeological deposits, in addition to changes in land-use patterns in and around wetland sites, generally weaken or break down the preservation potential of such an environment (*e.g.* French and Taylor 1985; Blanchette *et al.* 1991; Corfield 1993; 1998; Coles 1995; French *et al.* 1999; Blanchette 2000; Jordan 2001; French 2003, 159–71; Holden *et al.* 2006). For example, change in the chemical composition of the soil and groundwater complex is dependent upon penetration by foreign toxins into the water sources or by the infiltration of surface water through soils that have become chemically imbalanced by foreign toxins. The drying-out of the soil can also change its chemical state, leading to the formation of secondary minerals that change soil texture, water content and pH (French *et al.* 1999, 55; Chadwick and Chorover 2001). Development work in the local vicinity, such as deep piling for building foundations, is one example where the potential for lowering of the groundwater table is significantly increased (Brunning 1996, 4).

The degradation of the preservation environment is therefore also dependent on a range of external and internal stimuli, and should be regarded as a natural part of the dynamic morphological change of peatlands. However, changes in soil conditions, particularly those affected by anthropogenic factors, may significantly accelerate degradation or change the nature of degradation entirely.

Dewatering through peat wastage has been identified as a primary factor in the destruction of waterlogged archaeological materials (Van Heeringen and Theunissen 2001; 2002; Björdal and Nilsson 2002). Peat wastage is the result of desiccation, oxidation and microbiological action, and is a process that may be quickened by factors such as artificial drainage, wind erosion and variable climatic changes. Peat wastage has been recorded in the Fenlands with alarming results. Peat deposits at Holme Fen shrank by 3.9m between 1848 and 1950 (Hutchinson 1980), and the introduction of new drainage schemes has been estimated to account for annual peat wastage of up to 220mm (French 2003, 160). The consistent and intensive drainage of the Fenlands since the medieval period has deflated peaty deposits across the region, creating very fragile and highly desiccated contexts (French 2003, 161).

The effects of climate change are expected to accelerate unmitigated processes of peat wastage and evapo-transpiration (Walters 2001), with a general rise in temperature, drier summers and increased potential for flooding in winter (IPCC 2007) all likely to further damage the burial environment.

Classifying degrees of preservation and degradation

Various direct forms of classificatory analysis for the state of timber and pollen preservation, such as moisture content, cellular degradation or relative wood density, are currently available (Christensen 1970; De Jong 1977; Björdal *et al.* 2000; Spänhoff *et al.* 2001; Chapman and Cheetham 2002; Jones *et al.* 2007). A number of these techniques have been employed in specific monitoring projects at Flag Fen, as described below. However, limited finances have meant that, with the exception of the most recent developer-funded projects north of the timber post alignment (Meadows 2007), many of these microscopic analyses have not been possible on the excavated material. Instead, these have been replaced by a classification of the analytical potential of the surface of the timbers which entails a six-fold condition score (Fig. 1.1) taking into account the wood's investigative potential for species identification, dendrochronology, woodland management, woodworking technology and museum conservation (Therkorn *et al.* 1984; Van de Noort *et al.* 1995; see Bamforth, Chapter 4, this volume). When utilised in conjunction with a record of the height above ordnance datum for the tops of the posts, the condition score informs a relatively firm indication of the rate of change in the preservation environment.

General observations at Flag Fen

Although this chapter is primarily focused upon a broad area of study towards the western environment of the post alignment, a number of observations regarding the changing condition of organic deposits and their burial environment have been made over a number of years for areas towards the east and more central confines of the platform and post alignment. While there are no microscopic data to support these observations they deserve mention because of the long-term familiarity of the observers with the site's geological character and its overall changing nature.

Investigations at Flag Fen have repeatedly confirmed a general sequence of Flandrian deposits comprising a topsoil overlying reddish-brown desiccated peats and layers of alluvial organic muds capping a thinner layer of unhumified saturated peat, most probably of Middle Bronze Age date (French 1992; 2001; 2003, 97–112). Variation, particularly in the thickness of the deposits, has been identified throughout Flag Fen. For example, investigations along the western stretches of the post alignment have been situated in an area that until 2003 was subject to the pumping of sewage sludge into the topsoil for agricultural land use. This area is known as the 'slurry field'. Here the topsoil was composed of an alluvium with an organic clay-like sewage sludge admixture.

There are two groundwater systems active within the geological sequence of the Flag Fen basin (Smart 2008). The natural aquifer flows eastwards from Fengate and is

Grade	*Condition*	*Species ID*	*Dendro-chronology*	*Woodland management*	*Technology*	*Museum conservation*
0	Non-viable	-	-	-	-	-
1	Very poor	-/+	-	-	-	-
2	Poor	+	-/+	-/+	-/+	-
3	Moderate	+	+	+	-/+	-
4	Good	+	+	+	+	-
5	Excellent	+	+	+	+	+

Figure 1.1. A grading scheme for assessing the analytical potential of waterlogged wood (after Therkorn et al. 1984 and Van de Noort et al. 1995)

confined to the basement gravel deposits. Comprising the lower aquifer, and unrelated to the artificial drainage system, this has ostensibly remained unaffected by the pressures of modern urban and industrial development. Superimposed on this is an upper aquifer which lies within the peat and alluvial fill of the Flag Fen basin as a perched water system between about -0.2 and +2.5m OD; unlike the lower aquifer, this has been subject to continued artificial drainage and development. These modern pressures, particularly from Peterborough's Eastern Industry zone in Fengate, will serve to both accelerate a downward trend in the groundwater table and increase the through-put of surface water (often of varying quality and containing contaminants) through the upper aquifer of the Flag Fen basin. Almost all of the following observations refer to this upper aquifer, with the direct threats of dewatering and water-quality change to the system and the archaeological record contained within it.

The draw-down effect of the Mustdyke, which has been deepened every ten years since 1972, has been a continuous concern ever since the first timbers were found protruding from its sides, and the processes of drying-out were soon noted in trenches within its vicinity (Pryor *et al.* 1986, 9). Borehole surveys in 1983 and 1984 recorded the water table at or below the highest level of the horizontal timbers. By 1992 the bottom of the dyke was thought to be more than 1m below the top of the underlying Pleistocene clay-capped gravels, and around 2m below the highest timbers of the Bronze Age platform (Pryor 1992, 442). While successful mitigation procedures have maintained a saturated environment around the central area of the platform (Pryor 2001, 11–16), by the hot summers of 1991 the post alignment outside the artificial mere was deemed 'too dry to re-water and […] now at serious threat of rapid destruction' (Pryor 1992, 443).

In 1990, saturation of the Northey landfall was considerably less than had previously been encountered during farming practices and archaeological investigations (Pryor 1992, 456). Today, this course of destruction appears to be not only continuing, but accelerating. In 1999, posts of the alignment exposed as part of the *Time Team* excavations (Chapter 3, this volume) were still of such an integrity that a preservation grading based on their analytical potential for woodworking technology and conservation was considered to be 'moderate'. In 2003 a trench (2003/2) opened adjacent to the *Time Team* investigations (TT7) but slightly lower on the landfall could reveal only the remains of post-holes, some of which contained dry fragments of completely desiccated wood. This was a particularly hot summer, and cracks up to about 80mm across had opened in the dry ground to a depth of up to 0.5m, dangerously close to the tops of the surviving posts. The same depths were noted in 2005 for cracks that had opened on the Fengate landfall to the west of the basin.

Towards the central basin the water table has varied considerably. This is discussed in more detail below, but may be illustrated by a brief example. In the summer of 1988 a polythene-lined pond was constructed to the south-east of the main mere as an experiment in isolated preservation. The trench dug for the polythene 'skirt' was described as 'entirely dry', possibly as a result of hot summers drying and cracking the clay-capped Pleistocene gravels (Pryor 1992, 443). However, two 1m^2 test pits excavated within the drained pond in 2004 were completely saturated. Clearly Flag Fen has experienced recent episodes of extreme fluctuations in the water table that are not accounted for by climatic variation alone.

Non-intrusive assessment of the burial environment

Water-table monitoring

In 2002 a preliminary monitoring assessment of fluctuations in the water table was initiated through a piezometer survey by the Wetland Archaeology and Environments Research Centre from the University of Hull over a ten-week period between February and April, the results of which have been published in full elsewhere (Lillie and Cheetham 2002; Lillie 2007). The survey deduced that water-table activity along the line of the post alignment at Flag Fen was fluctuating towards a level below the top of the posts, placing the organic components within the study area under severe threat of degradation.

Methodology

Five clusters of up to three piezometers were positioned at regular intervals along the course of the post alignment for approximately 600m from the Fengate landfall towards the centre of the basin (Fig. 1.2). The locations of these clusters were determined by twenty-four boreholes utilised for stratigraphic recording in conjunction with a GPS survey to model the surface and buried land surface topography, as well as the depths of the peat and alluvial deposits.

The ten-week period of recording coincided with the wettest time of year, when the water table was expected to be at its highest, providing an indication of the degree of risk potentially experienced by the organic components during drier months. Obvious limitations within such a project are the short duration of study and the lack of comparative or baseline data. In spite of this, it was hoped that such an exercise, when placed in conjunction with the broader spectrum of empirical data and observation at Flag Fen, would provide a preliminary indicator of the saturation conditions in which the waterlogged deposits lay. In the discussion at the end of this chapter the results of this water-monitoring exercise are compared to the groundwater levels recorded during excavations in 2005.

Results

Differential water-table activity was observed at locations along the survey area. Two discrete bands of water-table activity were recorded, the lowest associated with the sandy

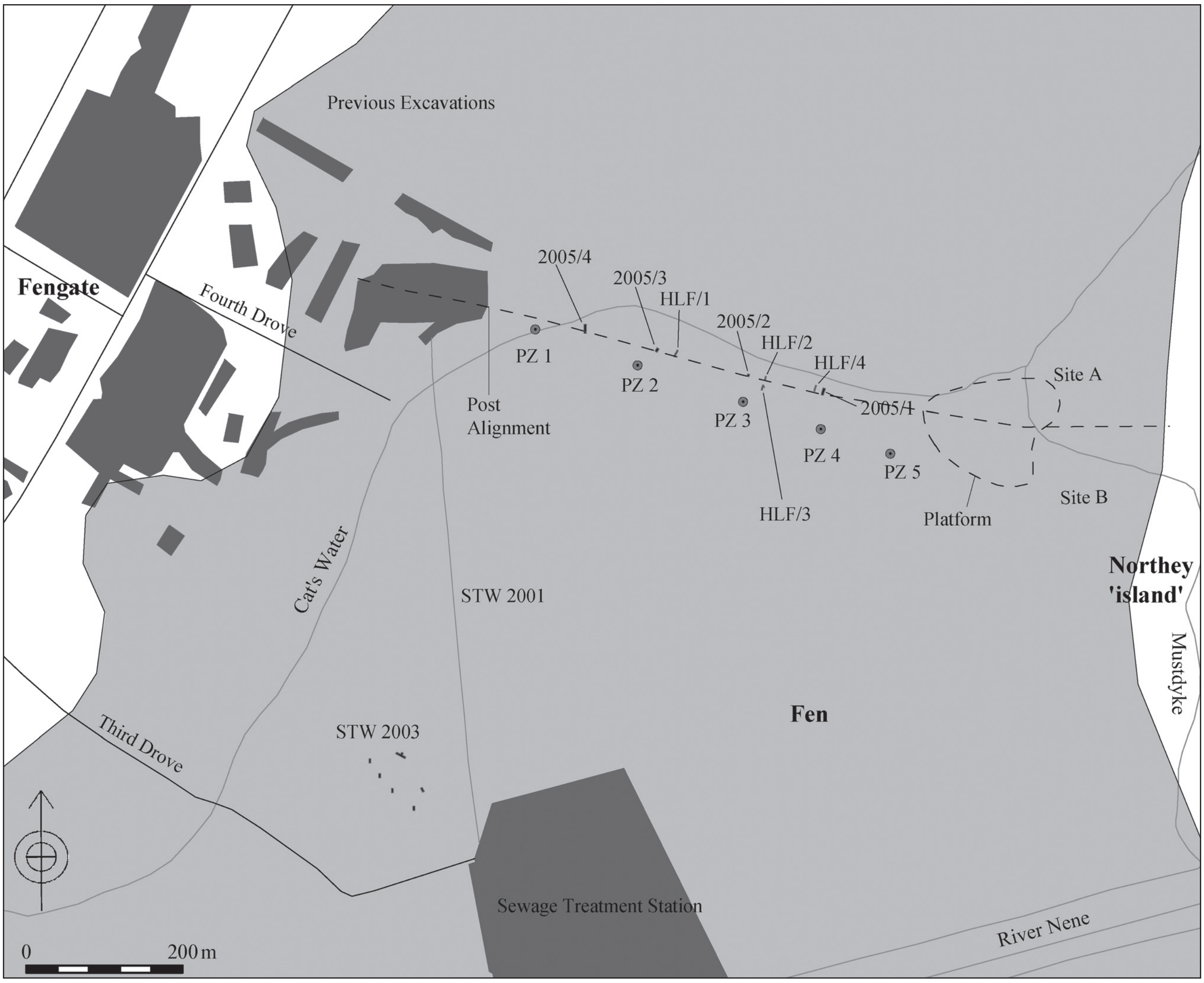


Figure 1.2. Location of 2005 investigations, piezometers and microbial analysis sites (A and B)

clays and gravels underlying the organic sequence, and the highest associated with the peats at varying levels across the survey area. At the higher subsurface topography of the Fengate landfall to the north-west, particularly with Piezometers 1 and 2, periodic saturation of the basal peats and laminated muds, with a water table fluctuating between *c.*0.5m and 0.6m OD, was accompanied by occasional, but limited, water-table activity within underlying sandy clays and gravels at the foot of the landfall between -0.2m and +0.2m OD. As the topography dropped towards the lower buried land surface in the basin to the south-east (Piezometers 3–5), the distinction between the two bands became more marked. Here the underlying sandy clays and gravels exhibited a water through-flow between -0.2m and +0.3m OD, and the basal peat, although saturated, fluctuated between 0.357m and 0.557m OD at Piezometer 3, and -0.123m and +0.157m OD at Piezometer 5 in the lowest depths of the basin. Significantly, each of these levels lie substantially below the highest survival height (approximately 0.95m OD) for any of the vertical timbers of the Flag Fen post alignment observed between 2000 and 2005 (see below).

During the period of survey water table activity at the Fengate landfall was clearly limited and episodic. Serious doubts about the survival of organic components were therefore expressed for this side of the post alignment. Where the depth of the basin fell in a south-easterly direction, water-table activity was more constant, but never exceeded 0.557m OD. Overall, water-table activity was confined within the band between -0.2m and +1.2m OD.

Microbial decay analysis

A 550-day experiment was conducted as part of doctoral research in microbial decay by Karen Powell of the University of Sussex in 1999 (Powell 1999). The aim was to examine the relationship between the physical

	Site A	*Site B*
Preliminary observations	Highly acidic soil High groundwater table Mildly reducing redox potential	Mineral soil with neutral pH Low groundwater table Mildly reducing redox potential
Observation after 119 days	Some decay Main decay type of soft rot fungi – often found when oxygen levels are too low for attack by white rot fungi (basidiomycetes).	Advanced decay
Observation after 323 days	Soft rot and bacterial decay	Progression of decay with soft rot prominent
Observation after 550 days	Increase in microbial decay, limited compared to Site B	Further increase in microbial decay with soft rot remaining more prominent than bacterial attack

Figure 1.3. Summary of burial environment and decay of buried modern timbers at Flag Fen (after Powell et al. 2001)

and chemical conditions of the archaeological sediments 1.5m below the ground surface and the types of decay affecting modern timbers of various species buried at two sites within the Flag Fen basin. A full methodological description and dissemination of the data has been published elsewhere (Powell *et al.* 2001). The results demonstrated significant differences in burial environment according to site location.

Two study areas were investigated. Site A was positioned near to the Hudson Barn to the north of the post alignment and platform, while the reconstructed Bronze Age village south of the post alignment contained Site B (Fig. 1.2). Although the rate of decay of modern timbers was significantly greater at Site B, which was positioned in the vicinity of the slurry field to the south, decay also affected timbers buried at Site A (Fig. 1.3). However, considering the short time-scale of the study the level of degradation on the modern timbers was considered to be substantial. This also confirms that two quite different burial environments may be located in the vicinity of principal archaeological deposits. Site B was aerobic (+17mV), of neutral acidity (pH 7.1), and with a relatively low depth of groundwater below the wood samples (0.57m). These values for acidity are concurrent with neutral values previously retrieved from the Area B excavations (Caple and Dungworth 1998). By contrast, Site A was almost anaerobic (+28mV), high in acidity (pH 3.5) and with a shallower groundwater depth below wood samples (0.1m).

Neither burial environment successfully replicated the anaerobic conditions present in archaeological horizons, but the results clearly suggest that, of the two study areas, Site B is highly unsuitable for the *in situ* preservation of archaeological organic material. This is unlikely to have changed since 1999. Although Site A was considerably less detrimental to archaeological organic material, it was clearly also unsuitable for long-term preservation. The implications of these results are serious for Flag Fen. The geological environment of Site B encompasses a significant area of the post alignment that has undergone little investigation. Indeed, as the small-scale evaluations from 2005 illustrate (see Chapter 2, this volume), the organic archaeology along this western stretch of the alignment is experiencing continued and accelerating degradation. Furthermore, the proximity of Site A's location to the platform presents a concern for the security of preservation of outlying or associated structures, including the eastern stretch of the post alignment, which, as the observations above suggest, is also undergoing severe and irreversible degradation.

Intrusive assessment of the burial environment

Excavations along the western extent of the post alignment since 2000 (presented in detail in Chapter 2, this volume) have recorded preservation values differing in both degree and type. As discussed below, these signatures may be indicative of both modern and ancient degradation, but equally serve to illustrate the complexity of the preservation context at Flag Fen and its continued decline.

Intrusive investigations within the Flag Fen basin have shown how preservation is varied, often locally, by degree and type. For example, a watching brief at the Flag Fen Sewage Treatment Works during the winter of 2000 observed that the layer of humic peat correlated with archaeological deposits elsewhere in the Flag Fen basin 'was in relatively good condition, with no sign of desiccation', whereas a second watching brief during the following month concluded that the alluvial clays to the north-east were 'relatively poor' and 'noticeably drier than would be normally expected' (Britchfield 2001).

It was a primary aim of trial excavations in 2005 (2005/1–4) to assess and map the degree and current state of these variations in preservation along the western extent of the post alignment. Four trial trenches revealed the tops of vertical posts at between 0.47m and 1.235m OD, with

the analytical value of the exposed wood ranging from moderate to very poor. However, voids between the peat and the vertical timbers were a common indication of peat shrinkage across the study area. Furthermore, mineralisation was observed within the upper profiles of each of the four trenches. This is of particular concern, because it is often a result of natural chemical changes induced by oxidation that can deteriorate the structure of the wood. Ions within the structure of the wood become actively chelated by cellulose and tannates, resulting in much higher concentrations of corrosive iron salts, which are converted into sulphides, blocking the pores between lumina and preventing saturation of the wood cellular structure (Kaye 1995, 36). The most notable indication of these degradation processes was the comparison of the condition of timbers from a trench opened in 1987 (Area 2) with those exposed in trench 2005/2. In the eighteen-year period between excavations the timbers had changed from large split oak vertical posts and two layers of horizontal timbers with a grading value of 'good' to a near-absence of any horizontal timbers, which had been replaced by mineralised traces that were completely devoid of any analytical value.

Additional variations of the preservation values across the study area in 2005 may have resulted from subtle differences within the geological profile. For example, a promontory of naturally elevated drift geology projecting into the basin from the Fengate landfall (Britchfield 2001), first identified in 2000, appeared to correspond with a paucity of wood preservation within trench 2005/1. Moreover, the variation in preservation highlighted an interesting challenge: that of distinguishing between ancient and modern signs of degradation. For example, in trenches 2005/1 and 4 the 'ghosts' of trimmed vertical posts were found in section adjacent to uprights that were relatively well preserved (Fig. 1.4). In 2007 a similar observation was recorded to the north of the post alignment, where decayed wood was found intermingled with wood of a higher preservation value (Meadows 2007), discussed in more detail below. Whether or not this is evidence of ancient decay or the quality of the timber when deposited into the fen, it suffices to say that these examples act as a reminder to take a range of factors into account when processes of degradation are at issue.

Figure 1.4. A 'ghost' post (feature 2) found in trench 2005/4

Discussion: the changing state of preservation at Flag Fen

The changing conditions of the preservation context at Flag Fen have been an ongoing concern with regard to the site's potential for yielding further high-quality archaeological information. It is evident that at present an adequate level of preservation exists across the site as a whole for the retrieval of prehistoric organic remains and other data that could significantly add to the ever-evolving narrative of the Flag Fen basin (see Chapter 2, this volume). However, an important distinction must be addressed. Timbers (and indeed, yet to be discovered earthfast features of pre-Bronze Age date) that are set into the basement drift geology of the basin, below approximately -0.2 to -0.5m OD, are contained in the saturated and relatively permanently waterlogged lower aquifer system. In general, the horizontal and vertical elements of the Bronze Age post alignment and the platform, sit between +0.5 and -0.2m OD, and are primarily in the upper aquifer system. Importantly, it is this system that is at continued risk of dewatering and organic degradation.

There has been a considerable and continuous degradation of the archaeological resource at Flag Fen. In spite of the current potential for the retrieval of detailed information at localised positions along the post alignment, comparison to technological and organic data reported from previous investigations indicates that a time is fast approaching when detailed information may no longer be attained. In particular, the drastic change in preservation of timbers over a period of two decades within the vicinity of 2005/2 and Area 2 of 1987 is an obvious cause for concern. Furthermore, the rate of dewatering and desiccation of timbers along the Northey fen-edge between 1999 and 2003 represents a serious and damaging transformation in the buried environment that, while likely to be variable in degree across Flag Fen as a whole, is indicative of accelerating degradation and

an urgent need for mitigation or reconciliation through a combined approach of monitoring, *in situ* preservation and excavation.

Drainage

Without baseline and non-anecdotal data it is difficult to quantify what may be regarded as 'normal conditions' at Flag Fen, although experience would equate this to a permanently saturated anaerobic basement deposit of reed peat overlain by an upper, drier deposit of desiccated reed peat. Generally, peatlands intercept surface run-off and precipitation as well as subsurface groundwater, and the movement of water within their geological layers varies with depth in terms of speed and direction of flow. This movement is significantly different in the two layers, with the upper peat facilitating high hydraulic conductivity compared with the low hydraulic conductivity of the underlying peat (Ingram 1978). While this distinction varies in degree between peatland types, ideal conditions for anoxic deposits will be equilibrium between seasonal recharge, discharge and storage of the groundwater (Chapman 2002, 41). Importantly, hydraulic fluctuation within peatlands is a natural component of seasonal climate, with most recharge towards equilibrium expected to take place in winter months. However, at Flag Fen a significant lowering of the groundwater table has been identified where sufficient recharge is not taking place, suggesting that the hydrological pattern has been altered and equilibrium severely disturbed. Clearly there has been a thinning of both the upper and the lower aquifers at Flag Fen through increased artificial drainage.

Initially, the main effect of artificial drainage such as a dyke system is a lowering of the water table as the potential for increased surface run-off is provided by a new routeway. Because the lower aquifer at Flag Fen should allow only low hydraulic conductivity under 'normal' conditions, the effect would usually be gradual, first impacting upon the upper aquifer, and then working downward. In unusually dry conditions this effect becomes intensified as water-table elevations are inhibited from returning to the elevation of normal conditions because of the absence of precipitation recharge. As a result, drained peatlands usually display greater variation in groundwater depth than do undrained peatlands (Ingram 1992), although punctuated equilibrium may still be maintained. Desiccation and mineralisation within the highest band of the lower aquifer, observed during investigations at Flag Fen, are signs of nitrogen loss and increased aeration. Furthermore, open cracks in the upper peats and the shadows of closed cracks after resaturation within the lower peats along the western stretch of the post alignment indicate that seasonal discharge is reaching depths much lower than the water table can sustain throughout the remainder of the year. This justifies concerns raised during water-table monitoring that the burial environment was under threat of drying-out. Here groundwater activity was confined to the band between -0.2m and +1.2m OD, whereas in 2000 and 2005 the tops of the upright posts were recorded between 1.235m and 0.47m OD. According to these observations the integrity of preservation along the post alignment has become severely compromised.

In general, fluctuations in the groundwater table have been considered harmful to organic preservation, seasonally exposing the burial environment to aeration. However, as explained above, fluctuation in the hydrological regime is a natural component of seasonal climate. However, concern is justified when fluctuation is imbalanced. This may include a number of seasons of imbalanced fluctuation followed by seasons of balanced fluctuation, or equilibrium, in the groundwater table. Importantly, this may be a pattern repeated over decades, exposing archaeological deposits to conditions that might normally be considered detrimental for long-term preservation. Noting similar observations from the Somerset Levels, Brunning (2007, 194) suggests that the survival of the archaeological resource under these conditions is likely to be 'governed by a range of factors that are not yet fully understood', hence further complicating the relationship between organic preservation and anoxic conditions. For example, the relationship between organic preservation and anoxic conditions may vary according to differences in peat composition from one location to the next where contrasting types of fen peat may significantly affect the degree of redox potential (De Mars and Wassen 1999). While this does not deter from the detrimental effects of intensified artificial drainage at Flag Fen, it highlights the necessity to consider a range of factors when assessing changes in hydrological patterns and chemical composition at wetland sites.

Land use

The intensity or form of land use can transform the character and chemical composition of the burial environment. The addition of fertilisers and manure have been shown to be influential in the alteration of landscape character (Davidson *et al.* 2007), and the injection of sewage sludge into the topsoil of the south-western area of the Flag Fen basin has long been thought to be an artificial characteristic of the peat that could enhance the anoxic conditions of the burial environment (Powell 1999). As well as potentially having adverse effects on the stability of timber preservation, agrochemicals may also initiate corrosion on buried archaeological bronzes, iron and bone (Tronner *et al.* 1995; Pollard *et al.* 2004; Nord *et al.* 2005a; 2005b; 2002), all of which are represented by substantial assemblages at Flag Fen. While a test for heavy metals, acidity and microbial transport may provide a suitable indicator in future studies for the degree of pollution encountered by archaeological deposits (Taylor *et al.* 2004), the measurement of phosphate has been carried out at Flag Fen during excavations in 2005 as a 'guide proxy' for the effect of sewage sludge on the archaeological resource (Appendix 2). Significantly, phosphate nutrients did not appear to have leached into the lower peat deposits. Instead, where the injected slurry had formed into a firm mineralised layer beneath the topsoil

the general effect may have been that of a semi-permeable membrane in localised areas, where the deposit is thickest (*c.*0.1m), limiting the vertical groundwater flow and increasing surface run-off, although probably remaining a minor factor in any changes to the water table.

Condition of the wood

As Michael Bamforth explains in the wood analysis (Chapter 4, this volume), the majority of the timber that has survived along the western stretch of the post alignment has been attributed a grade of 'moderate'. This is the borderline for meaningful analysis, and is not just a value associated with this feature, for grades of very poor to moderate have characterised the wood uncovered to the north and south of the post alignment. This is in significant contrast to the condition of the wood in Area 6, last excavated in 2001, when it was graded as 'good'. This difference may be a result of recent degradation caused by changes in the burial environment across Flag Fen as a whole, but there are also localised variations in preservation along the post alignment that are due to a combination of factors that still elude clear understanding.

As suggested above, factors accounting for these processes may include geological variation or the condition of the timbers when they were first deposited during the Bronze Age. In this case, ancient pre- and post-depositional decay may have eventually become 'preserved'. The 'ghost' uprights found adjacent to preserved vertical timbers in 2005 provide an interesting example, as both timbers would have experienced similar, if not identical, burial environments. Since the distribution and nature of chemical components within wood is determined by the tree species, different types of tree species may at a molecular level suffer different rates or types of decomposition (Taylor 1981; 2001, 169; Van de Noort *et al.* 1995). However, both alder and oak species were represented by the preserved timbers, so it is unlikely that a difference in species can account for the vastly differentiated levels of preservation in this instance. Likewise, aeration through root activity may be discounted due to the absence of relict or more recent traces of such action. It is possible, but difficult to verify, that this is a record of episodes of decay in antiquity, with the better-preserved timbers being later additions to an earlier post alignment already undergoing a process of decay. Elsewhere, decayed posts within the post alignment were found beneath a purpose-built gravel platform protruding into the basin from the Fengate shoreline (Pryor 2001, 59). The decayed posts, which elucidated the phasing difficulties inherent in the relationship between the gravel and those posts sticking through the top of the gravel, were also evidence for an episode during the use of the post alignment when conditions facilitated degradation of the timbers. Significantly, this episode of degradation was eventually preserved alongside later timbers which did not carry these signatures. In other cases, variable preservation may be due to the reuse of timber for the construction of the post alignment, as has been noted for a number of the horizontal timbers (see Chapters 2 and 4), on which weathering and wet rot has already taken place (Pryor 2001, 121; Pryor *et al.* 1986, 20). In any case, care must be taken when simply attributing the quality of preservation to the depth of the deposits as many other factors may be at work.

Conclusion

Over the past twenty-five years a continual process of degradation in the condition of the waterlogged timbers of the post alignment has been observed. However, the nature of degradation at Flag Fen appears to have accelerated in recent years to a rate that threatens the long-term preservation of this fragile archaeological resource.

At present the condition of the waterlogged remains has been classed as 'moderate', but, as noted above, this value represents the borderline of meaningful analysis. As a classification this cannot be improved. At best, the current state of the remains can be maintained through steady hydrological management, but the current hydrological regime at Flag Fen will most certainly continue to foster degradation, although at a rate that is unclear.

As the following chapter illustrates, in spite of the deteriorating condition of preservation recent investigations have shown that organic information is still currently obtainable along a stretch of the post alignment that remains under-explored. While much of this information confirms previous arguments proposed for the central and easterly stretch of the post alignment, it has also highlighted a number of anomalies and raised new questions for the character of the post alignment to the west, and the relationship of the basin to communities along the dryland of Fengate from the Neolithic through to the Iron Age.

Clearly a continued programme of hydrological monitoring at Flag Fen is essential in the drive to understand the processes of desiccation and preservation in this localised environment. This requires a combination of techniques, including intrusive excavation, a variety of comparative baseline data and a strong degree of sensitivity to the changing requirements (development, drainage, land use and so on) of the surrounding environs. This is a two-way relationship important for the nourishment of a continuously unfolding and exciting biography.

2. Excavations within the Western Flag Fen Basin: 1997–2007

Marcus Brittain

This chapter describes the results from a number of excavation programmes that have been carried out since 1997 within the vicinity of the post alignment and platform of the Flag Fen basin. The focus here is specifically on the waterlogged organic archaeology of the western stretch of the post alignment located between the Fengate landfall and the English Heritage-funded excavations on the platform. The excavations located to the easterly edge of the basin on the Northey landfall are discussed in detail in Chapter 3.

As discussed in the previous chapter, there has long been a concern that the preserved organic remains at Flag Fen are undergoing an accelerating process of degradation, leading to a loss of archaeological potential. It was this concern that prompted, along with the microbial and groundwater-table monitoring, the two primary investigations outlined in this chapter: those of 2000 and 2005. While the overall aim of these two seasons' investigations was specifically an assessment of the preservation conditions of the organic deposits, the character of the post alignment itself warrants discussion since the exposed areas were located upon a part of the post alignment that has received little previous investigation. In addition, a number of developer-funded investigations have taken place within the vicinity of the post alignment, and the results from these works provide further context to both the preservation environment and material character of the archaeological deposits.

The general nature of the deposit sequence encountered within investigations at Flag Fen was outlined in Chapter 1, and the variation within this sequence is discussed below in more detail. As previously mentioned, the deposit sequence roughly corresponds with previously published Flandrian deposits (French 1992; 2001; 2003, 97–112). Within the study area of the western stretch of the post alignment the agricultural land use up to 2003 incorporated the pumping of sewage sludge into the topsoil, leaving a composition not encountered elsewhere within the basin. The topsoil was therefore composed of alluvium with an organic clay-like sewage sludge admixture above reddish-brown desiccated peats and alluvial organic muds which overlie a thinner layer of Middle Bronze Age unhumified saturated peat (French 2001) (Fig. 2.1). The retention of water within this basal peat layer is due to the presence of a thin clay matrix binding the gravels of the basin substrate, thus creating a locally perched groundwater table.

Excavations south of the post alignment

South of the westerly stretch of the post alignment, where some of the greatest depths of saturated peat have been recorded, a number of developer-funded investigations have taken place within the vicinity of the Flag Fen Sewage Treatment Works (STW). The findings and profiles from these investigations enhance our understanding of the varying preservation conditions at Flag Fen, as well as of the archaeological potential of the southern extent of the basin in general.

Sewage Treatment Works excavations: 1997

At the end of June 1997, Soke Archaeological Services Ltd excavated thirteen test pits (Fig. 2.2) by mini-digger in advance of construction works at the Flag Fen STW (ST97/1–13) (Pryor 1997c). These revealed no traces of timber remains, and the ground conditions were too wet for the formation of a palaeosoil.

Irregularity in the deposit sequence was observed within ST97/6, where a thin layer of peat was identified between the humified peats and the organic muds, and any lower peat was absent. This inversion of the deposit sequence was probably caused by a nearby stream or watercourse. A relict stream channel which was identified along the edge of the terrace gravels during the 1989 Power Station excavations may have continued to flow seasonally during the Bronze Age (Pryor 2001, 50). In 1998 it was found that a succession of Pleistocene or Flandrian watercourses had also created a series of inlets further south along the fen-edge at Third Drove (Pryor 2001, 50). A similar sequence was observed again during excavations on the landfall in 2005 (see below). Even today the nearby flow of the Cat's Water drain still follows a natural course along the fen-edge (French 1997).

A wet environment was confirmed in each trench by

	Basic context description	*Trench year / number*				
		2005/1	2005/2	2005/3	2005/4	HLF/3
Corresponding deposits	Topsoil	100	205	300	400	001
	Silty clay sewage sludge	101	206		401	
	Desiccated clayey peat	107	207	301	402	004
	Silty clay alluvium	108		302	403	002
	Desiccated peat	102	208	303	404	003
	Moist peat with orange mottling	103			405	
	Re-saturated peat with sand horizons and mineralization	104	209	304		
	Fine grey silt		210			
	Dark greenish-grey clayey silt		211			
	Light greenish-grey clayey silt		212			
	Dark saturated peat	105	213	305	406	
Non-corresponding deposits	Soft greenish-grey clayey silt	110				
	Dark brown clayey (sand) silt		214			
	Greyish-white silty sand		215			
	Blueish-grey silty clay					005
	Light yellowish-brown sand				407	
	Weathered gravels mixed with blueish-green alluvium				408	
	Yellowish-grey sandy gravel				409	
	Loose mid-orange sand				414	
	Indurated dark orange fine gravel				415	
	Naturally raised sandy gravels	106				
		Natural gravels & Pleistocene clay				

Figure 2.1. General table of stratigraphic layers for each trench (HLF & 2005)

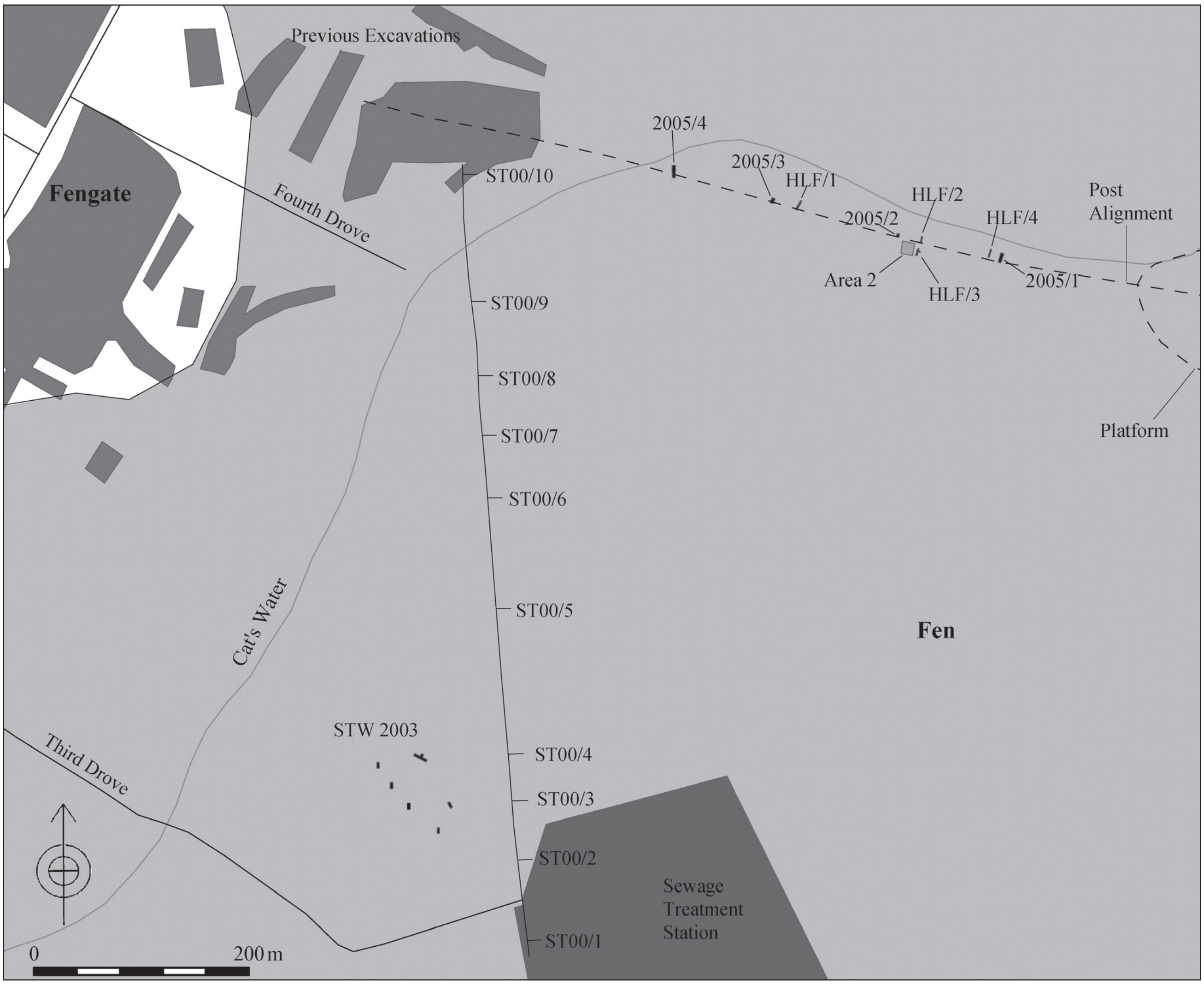


Figure 2.2. Location of investigations around the western extent of the post alignment

the lack of a palaeosoil between the lower peat or alluvial muds and the Pleistocene gravels. The low level of these deposits is the likely cause, the only exception being in ST97/13, at 1m higher than the rest, where there was a thin and weakly developed soil 20–30mm thick at the base of the laminated muds.

Sewage Treatment Works excavations: 2000–2001

Further proposed construction works at the STW necessitated a series of small evaluation trenches and watching briefs during January 2000 and the very wet months of November and December 2001 by Soke Archaeological Services Ltd (Britchfield 2001). Eleven soil profiles between 1m and 2m in length were recorded during a watching brief along the extent of a pipeline trench running north–south across the embayment (ST00/1–11). As with the 1997 investigations no timber remains were uncovered, and where modern disturbance had not affected the upper stratum the sequence of deposits corresponded with those previously published, varying slightly in thickness or, in the case of the alluvial muds, in colour and content. Again, there were no traces of a palaeosoil. However, a noteworthy feature was observed about 100m south of the alignment at Profiles 5 and 6 (Britchfield 2001), which were 100m apart (Fig. 2.2). Here natural gravels were encountered at *c.*1m OD, and were again identified in 2005 running parallel with the post alignment almost 200m north-east of the original observation. As discussed further below, this suggests that an extensive low-lying 'promontory' of naturally raised drift geology projects into the central reaches of the Flag Fen basin from the Fengate landfall.

Sewage Treatment Works excavations: 2003

By Ricky Patten

The Cambridge Archaeological Unit carried out a watching brief of six test pits (1×3m) excavated as part of a geotechnical survey in May 2003 (Patten 2003). This again confirmed the previously recorded soil sequence with the natural gravels observed between 0.18m and -0.32m OD. Five of the test pits produced no archaeological traces, but in Test Pit 4 a layer of abutting horizontal timbers oriented north-west–south-east was exposed at a depth of 0.83m OD (Fig. 2.3) Despite enlargement of the test pit, the full extent of the timbers was not established, although many were over 1.5m in length. The majority showed no observable traces of working; however, two of the timbers (A and B) displayed signs of possible working, with either an apparent indent cut along one edge (A), or what was recorded as possible tool marks along the sides and a notch at one end (B).

Excavations along the post alignment

By Marcus Brittain

Two seasons of excavation by the Fenland Archaeological Trust during July and August of 2000 and 2005 directly targeted the westerly stretch of the Bronze Age post alignment in order to assess the current and changing preservation conditions and to ascertain the possible impacts of both natural factors and proposed local construction works.

Investigations in 2000

Little investigation had been carried out on the post

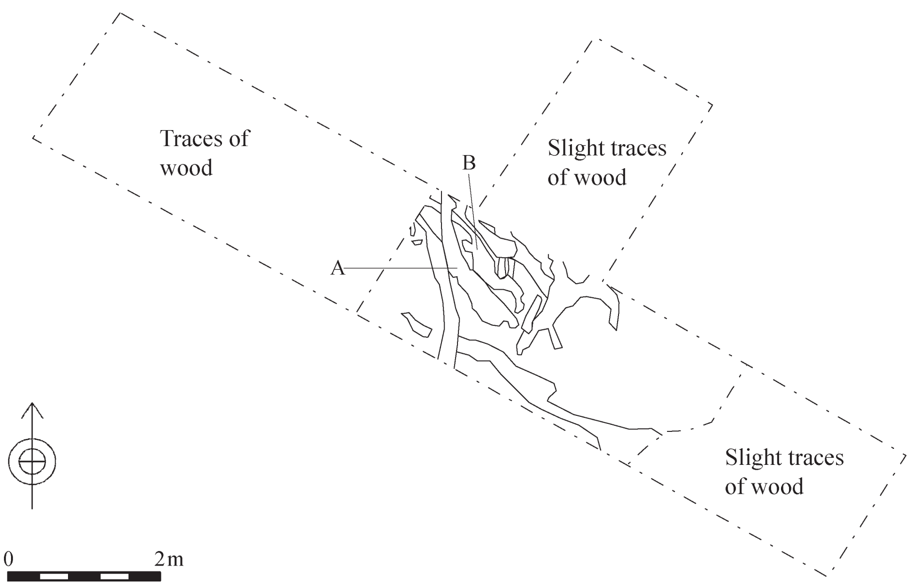


Figure 2.3. Trimmed timbers found south of the post alignment during STW 2003. Reproduced with permission of Cambridge Archaeological Unit

alignment between the artificial lake and the Fengate landfall until four trenches, each 1.5m×4m were opened with a mini-digger in 2000 (HLF/1–4) (Fig. 2.2). The aim was simply to determine with the least possible intrusion the presence and preservation of the timbers. With the exception of Trench HLF/3, outlying to the south of the post alignment, that was opened to expose a complete profile of the deposit sequence, excavation was halted at the tops of the posts where 3-dimensional points were recorded without excavating or removing any timbers or samples for further analysis.

Either one or two unidentified alignments of vertical posts with single outlying posts were revealed in Trenches HLF/1, 2 and 4 (Fig. 2.4, 2.5 and 2.6). HLF/3 did not reveal any additional outlying structural remains, but exposed a sequence similar to that previously recorded, except that beneath the topsoil the clay-like orange slurry deposit was much more clearly differentiated from a deposit of alluvial clay over reddish-brown desiccated peat in which the tops of the posts were exposed. Beneath this a thin layer of alluvial organic mud capped a layer of unhumified saturated peat (Fig. 2.7). The heights of the tops of the posts, ranging between 0.428m and 0.957m OD, were recorded for each trench. With the vertical timbers clearly located, it was apparent that the post alignment did not follow a straight course across the basin, but was slightly angled at a point to the west of the platform and redirected from its course with a 'kink' towards the Northey landfall.

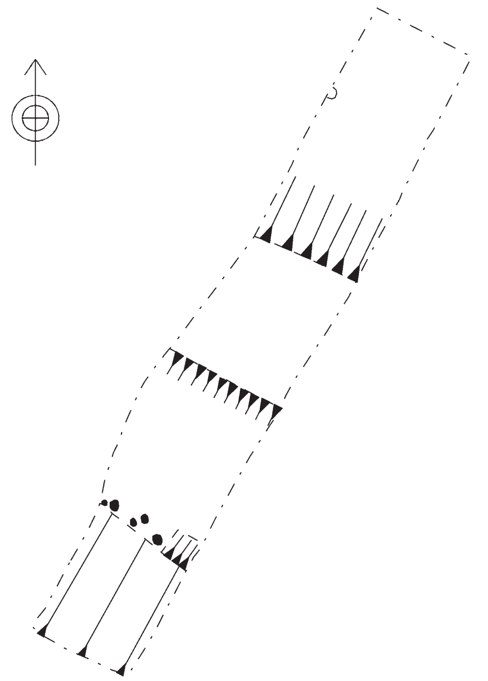


Figure 2.4. Plan of trench HLF/1

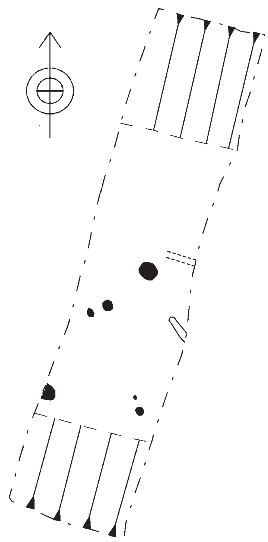


Figure 2.5. Plan of trench HLF/2

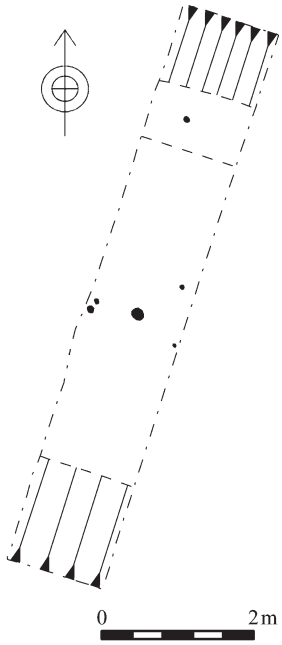


Figure 2.6. Plan of trench HLF/4

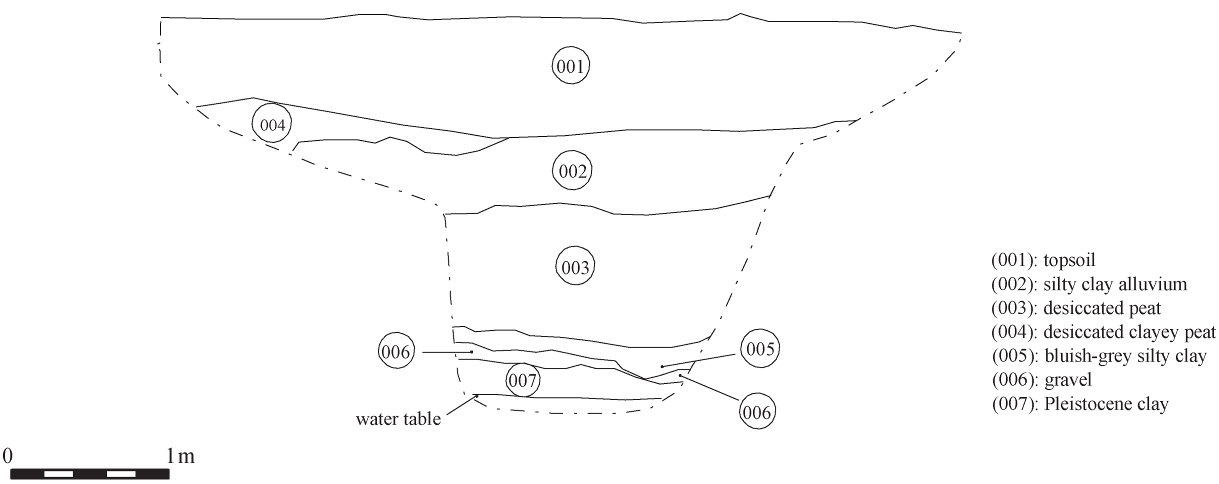


Figure 2.7. Section of trench HLF/3

Investigations in 2005

Heightened concern regarding the quality of preservation at Flag Fen, and the likelihood of impending development within its locality, prompted the decision to open a series of trenches across the post alignment in order to excavate and remove waterlogged timber samples for further analysis (2005/1–4). In addition to revealing an unexplored and relatively unknown stretch of the alignment for broader interpretative purposes, this provided an opportunity to quantify the nature and degree of the preservation environment in comparison to the knowledge formed from previous water-table monitoring, microbial analysis and spot-height referencing. The tops of the posts were identified between 0.47m and 1.235m OD, and each trench varied in degree and type of preservation, possibly as a result of both ancient and recent autogenic and allogenic processes. Analysis of the wood is discussed in detail in Chapter 4.

As with the previous excavations a similar sequence of deposits of varying thickness and depth was identified across the study area, with the ploughsoil overlying a layer of orange silty-clay sewage slurry, beneath which lay a sequence of desiccated peat, alluvial silts and saturated peat. However, the nature of the interface between the deposits varied from one trench to another, with the saturated peat displaying signs of desiccation, resaturation and mineralisation. The nature of these variations is discussed separately for each trench.

Trench locations

Four trenches were positioned along the post alignment at intervals of approximately 50m running from the Fengate landfall in the north-west towards the central basin in the south-east (2005/1–4) (Fig. 2.2). The locations of the four trenches were plotted close to or in accordance with the piezometers from the water-table monitoring and the alignment of the posts as deduced from the excavations in 2000. The proximity of these trenches to those from previous investigations offered a comparative basis for baseline analysis.

Methodology

Each trench was machine-excavated to the tops of the vertical posts, from which point excavation was carried out entirely by hand. Trenches 2005/1 and 4 were fully excavated, reaching the natural gravels beneath the waterlogged organic remains. In trench 2005/2 two quadrants measuring 1.5m ×0.5m were excavated to the underlying natural gravels, whereas in trench 2005/3 the first layer of horizontal timber was uncovered and recorded but not excavated. Three posts were removed from both trenches 2005/1 and 4, with photographic and preliminary recording taking place on-site and more detailed recording reserved for post-excavation analysis. A roofed paddling pool was erected on site for the temporary storage of excavated timbers. With the exception of trench 2005/1, which was excavated under the cover of tarpaulin spread over a scaffold A-frame, each trench was excavated without cover and regularly watered, with the tops of the posts protected by a plastic wrap. When excavation was not taking place the trenches were covered with lightweight tarpaulins to contain moisture and protect the deposits from direct sunlight and insects.

Owing to the previous agricultural land use across the site, it was necessary to test for contamination in the archaeological deposits resulting from the leaching of slurry nutrients. Therefore, as a guide proxy for the effect of sewage sludge on buried archaeological remains, levels of phosphate were tested at 50mm vertical intervals in trench 2005/1 since of the four trenches this was positioned nearest the central basin and the timber platform.

Trench 2005/1

A trench measuring 11m×3m and orientated north–south was opened at the south-easternmost point of the project area within the central basin (Fig. 2.2). The wood in this trench was better preserved than in the other three trenches, with three layers of waterlogged horizontal timbers. The tops of the vertical posts were observed between 0.83m and 1.1m OD.

It was possible to identify three rows of posts, oriented east–west, that from north to south appeared to almost mirror the characteristics described for Rows 5, 4, and 3 in Area 6 (Pryor 2001, 96). The northernmost row, identified as Row 5, was composed of a series of evenly spaced single and paired vertical posts forming an apparently straight and sharp northerly edge. Row 4, 2m to the south, was much more uneven in character and spacing with a series of vertical posts of much more varying diameter, some of which had been driven in at an angle, although not necessarily leaning towards the north (contra Pryor 2001). The third alignment, at the southernmost limit of the trench, was the closest match to the description of Row 3, with densely packed posts of mixed wood species. However, rather than being placed in a continuous bunched series the posts were packed into discrete clusters (contra Pryor 2001).

Three vertical posts (V37, V38 and V41) were removed from Rows 4 and 5 for closer analysis. Approximately 0.3–0.4m of the post tips had been very well preserved in the underlying muds and gravels at a maximum depth of between -0.01m and -0.19m OD. The lowest 50mm of the tips of V37 and V38 was encrusted by a rim of iron pan and manganese that upon removal revealed a trimmed pencil-like end (Fig. 2.8).

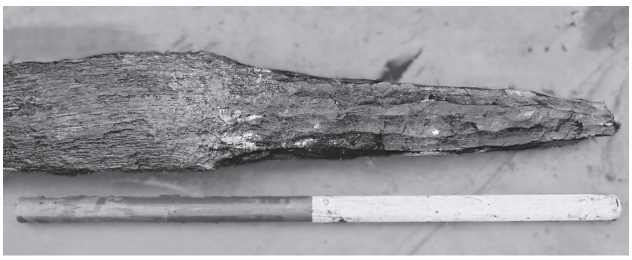


Figure 2.8. Timber V38, Upright post of the Bronze Age post alignment

Layer 1

The level of the first layer, Layer 1 (Fig. 2.9, 2.10 and 2.11), corresponded with the tops of the vertical posts at approximately 0.75m OD within a moist but mottled orangey-brown peat (103) with fragments of dark mineralised wood suggestive of oxidation and resaturation. Voids between the peat and the vertical posts were also indicative of peat shrinkage, particularly along Row 3. The condition of Layer 1 was generally very poor, with little identifiable preservation of wood technology or management.

A possible walkway was noted between Rows 2 and 3, corresponding with observations made in Area 6 (Pryor 2001, 96). Nine sherds of Late Bronze Age vessels and a single white stone were spread on the squared end of

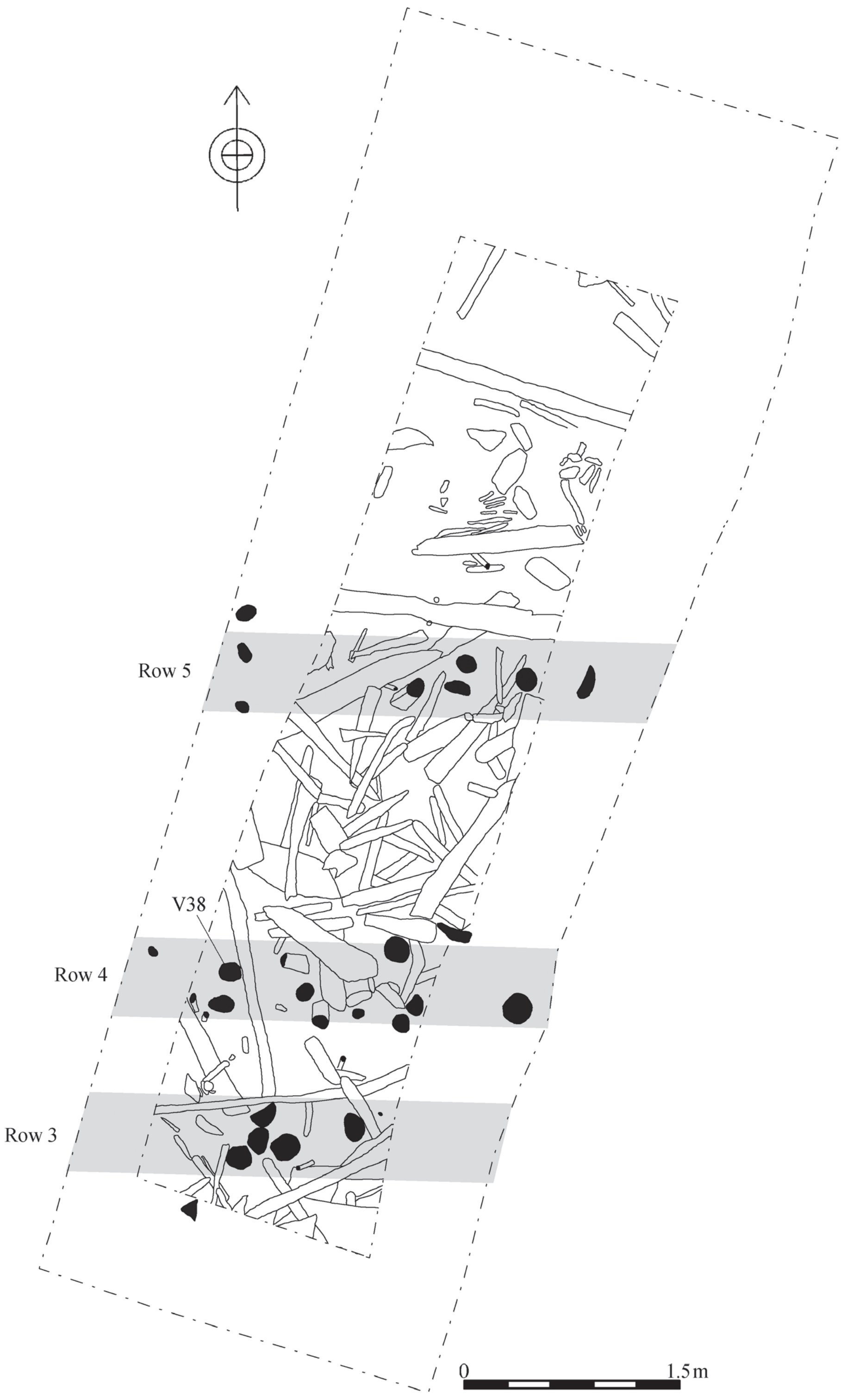


Figure 2.9. Trench 2005/1, layer 1

Figure 2.10. Trench 2005/1, layer 1, looking north

Figure 2.11. Section of trench 2005/1

Figure 2.12. Timber V52, horizontal timber with blind mortise

a large split horizontal timber running beneath the baulk edge to the south-west corner of the trench. Other split timbers were found lying horizontally beneath the trench edge to the south-east, but degradation was too advanced for further analysis.

The existence of a walkway between Rows 3 and 4 could not be irrefutably verified as only a thin scatter of poorly preserved wood remained. However, a further thirteen pottery fragments, again from vessels of Late Bronze Age date, were found scattered among the vertical posts of Row 3 and within the otherwise empty space between Rows 3 and 4. However, it is possible that these, too, are associated with a walkway between Rows 2 and 3.

A disproportionate amount of horizontal timber lay between Rows 4 and 5, with split timbers resting parallel to one another with a south-west–north-east orientation as part of what appeared to be the dilapidated remains of a walkway either partly dismantled or in a state of disrepair. Wooden finds included a reused blind-mortised plank (V52) and a plank with a housing-lap (V56) that had been lodged diagonally between Rows 4 and 5 (Fig. 2.12). Furthermore, two white oval pebbles were found among the wood of Layer 1 and within the peat between Rows 4 and 5. Similar observations have been made elsewhere along the post alignment at Flag Fen, as, for example, for TT4 of the *Time Team* excavations on the north-east stretch of the post alignment (Chapter 3, this volume), and the possibility of deliberate placement of these items should not be discounted.

Layer 2

Beneath Layer 1 a second layer of parallel horizontal timbers was found south of Row 3, and between Rows 4 and 5, at approximately 0.76m OD (Fig. 2.13). The wood comprising Layer 2 south of Row 3 was small, consisting mainly of fragmentary roundwood that had probably formed a stable base for the walkway of Layer 1. A slight sandy texture

within the otherwise moist dark peat (context 104) may have been a result of desiccation, but could also represent a small trace of a deliberate deposit laid across the walkway of Layer 1 to form a stable footing (see also Trench 2005/2 for discussion). Similarly, the timbers between Rows 4 and 5 were smaller than and perpendicular to the larger timber of Layer 1, and again appeared to have been laid as a base for a walkway.

A sherd of later Bronze Age pottery was found abutting a vertical post (V36) in Row 4 at 0.67m OD, 0.1m lower that those found in Layer 1. The sherd was embedded within the saturated peat of Layer 2 and it seems unlikely that it had slipped through an open void resulting from post-depositional peat and timber shrinkage from Layer 1. Instead, it further signifies the relative contemporaneity of Layers 1 and 2.

The most surprising feature of Layer 2 was the absence of wood between Rows 3 and 4. Instead, after the removal

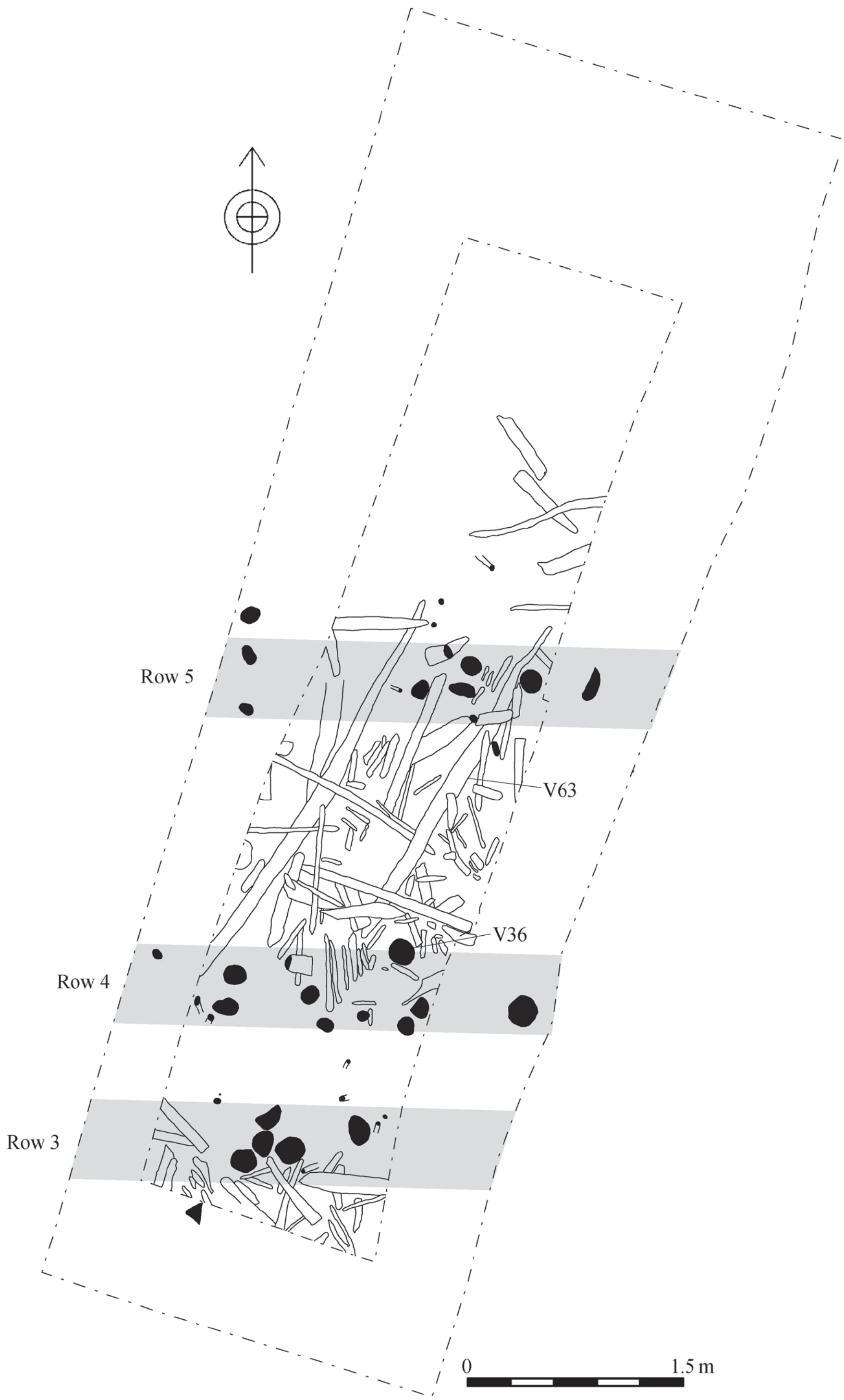


Figure 2.13. Trench 2005/1, layer 2

of Layer 1, 0.5m of well-preserved saturated peat resting upon a thin layer of greensih-grey clayey silt (110) on top of a bank of sandy gravels (106) was found. A transect of five auger profiles across the centre of the trench showed that Row 3 had been driven into a natural raised bank of sandy gravels, and that there was a clear and abrupt division between this and a deposit of deeper saturated peat and alluvial mud immediately to the north, into which Rows 4 and 5 had been driven. The gravel bank appeared to be the continuation of the raised gravels which were observed in STW 2000 (above) projecting into the basin from the Fengate landfall.

Layer 3

Lying beneath the small horizontal wood of Layer 2 were two large roundwood timbers more than 2.7m long. These traversed Rows 4 and 5, and one (V63) showed possible

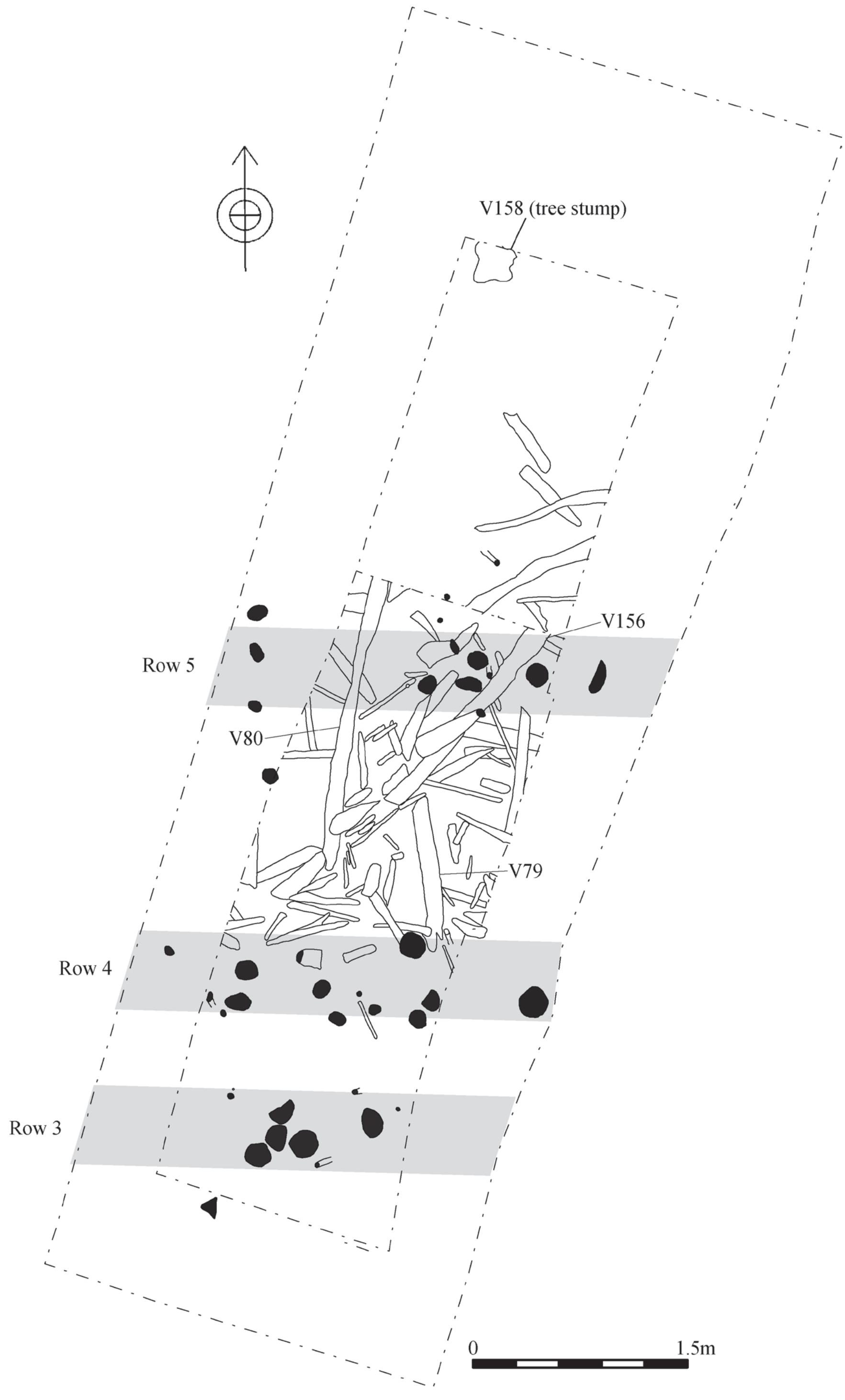


Figure 2.14. Trench 2005/1, layer 3

signs of trimming at one end. These may have been the highest remnants of a third layer, Layer 3 (Fig. 2.14).

This layer could only be located between Rows 4 and 5, possibly owing to the higher topography of the sub-peat natural sandy gravels (106) south of Row 4. Both the wood and the peat (105) were saturated and well-preserved, but any possible walkway could be inferred only from the rather haphazard alignment of wood; this was roughly oriented south-west–north-east, with three split timbers (V79, V80 and V156) over 1m long traversing Rows 4 and 5. This wood was larger than that of Level 2.

Only five poorly preserved wood specimens, which showed few signs of working, were found to the north of Row 5, and these were left *in situ*. In the north-east corner of the trench a small test pit revealed a stump (V158) with a rotted centre at 0.84m OD. While no signs of coppicing could be observed, this is perhaps the remains of fen carr, probably pre-dating the construction of the post alignment.

Additional observations

The removal of one of the primary vertical posts (V41) from Row 5 produced an interesting peculiarity in the morphology of the post alignment. After its removal, the cleaning of the adjacent section revealed the shadow (F1) of an additional post, the tip of which had been driven into the top of the sub-peat (105) clayey silt (110) through which each of the other vertical posts had passed directly to the basal firm stoney clay (111) (Fig. 2.15). This post, which had a diameter of 0.1m and was evidently more substantial than a simple stake, was clearly part of the alignment of posts for Row 5. It appeared to have rotted *in situ*, as a fill (114) of grainy reddish-brown desiccated wood was present; this was encased at the tip by indurated sandy clay (109), as was also the case for the well-preserved timbers. As discussed in the previous chapter, this raises questions about the condition of the timbers when they were first incorporated into the post alignment. This example also serves to illustrate the temporal engagement with the post alignment through the need for repeated maintenance and repair, as well as the addition of timbers to the post alignment, whether for structural or other purposes.

Trench 2005/2

A trench measuring 3m×3m was opened approximately 50m to the west of trench 1 (Fig. 2.2). At least two rows of posts were revealed, but the quality of preservation was too poor for the survival of any layers of horizontal timber. After machining to the tops of the posts, two quadrants measuring 1.5×0.5m were excavated at the centre to the natural gravels (Fig. 2.16) revealing a semi-formed land surface and associated artefacts pre-dating the post alignment. The proximity of trench 2 to a trench of similar size opened in 1987 (Area 2) meant that any change in the level of preservation over the intervening eighteen-year period could be measured with relative accuracy.

Despite being described as 'dry from top to bottom' in 1987 (Pryor 1992, 455), the preservation of the timbers in Area 2 was considered to be good, with large split oak posts and at least two layers of horizontal timbers present (Pryor 2001, 81–5). However, in 2005 very little horizontal timber was found throughout the sequence, making the identification of any discrete layers of wood impossible. The clearest signs of decay were observed below a band of orangey-brown desiccated peat (209) at 0.4m OD within a dark and moist peat deposit (210) containing traces of mineralised wood 50–100mm thick at the top and bottom. This distinct crumbly charcoal-like surface is indicative of high levels of oxidation, and may suggest that the peat was in a current state of resaturation after repeated dry episodes. The contemporaneity of these poorly preserved deposits to those displaying relatively good preservation in other trenches from 2005 is confirmed by a single sherd from a post-Deverel-Rimbury (PD-R) vessel (SF61) found within this mineralised surface.

Vertical timbers tend to be more resistant to decay than horizontal timbers (M. Bamforth pers. comm.), and the tops of at least seventeen posts forming two clear alignments were revealed between 0.47m and 0.83m OD. Only tentative identification of the rows could be made, but a tight cluster of split posts in the south-eastern corner of the trench was similar to the clusters comprising Row 3 in Trench 2005/1. This would suggest that Rows 3 and 4 were exposed in Trench 2005/2. Such an interpretation may be supported by the presence of occasional pockets of fine sand noted throughout the layer of mineralised wood. While this sandy deposit might be assigned to the natural desiccation process, a 'discontinuous spread of sand and fine gravel' was also encountered in the same rows in Area 2 (Pryor 1992:445), where it marked the level of the horizonatal timber planks. However, care should be taken when assigning the posts to specific rows based on the presence of sand, as thicker deposits of sand and fine gravel have also been found between Rows 1, 2 and 3 in Areas 6 and 8, where they were interpreted as deliberate deposits laid as secure footholds for walking on the wet planks (Pryor 2001, 85, 90).

The nature of the deposits below the resaturated peat (209) was different from any of that identified in the other trenches. Between 0.08m and 0.37m OD two layers of light (211) and dark (212) greenish-grey clayey silt rested upon a third deposit of silty peat (213) containing a retouched flint (SF62). Below this, between -0.05m and 0.08m OD, lay a discontinuous band of dark brown silty sand (214) followed by a composite greyish-white silty sand (215) with another retouched flint (SF64), along with small pieces of well-preserved wood (V66 and V67) with possible evidence of working. While these lowest deposits (214 and 215) were fully saturated, the higher clayey-silt layers (211–213) varied in water retention capability, but each showed signs of recurrent dewatering and resaturation, particularly evidenced by distinct open and sealed cracks within the matrix, although the water table appeared to fluctuate only between 0.22m and 0.28m OD during the

Figure 2.15. Feature 1 'ghost post' in section

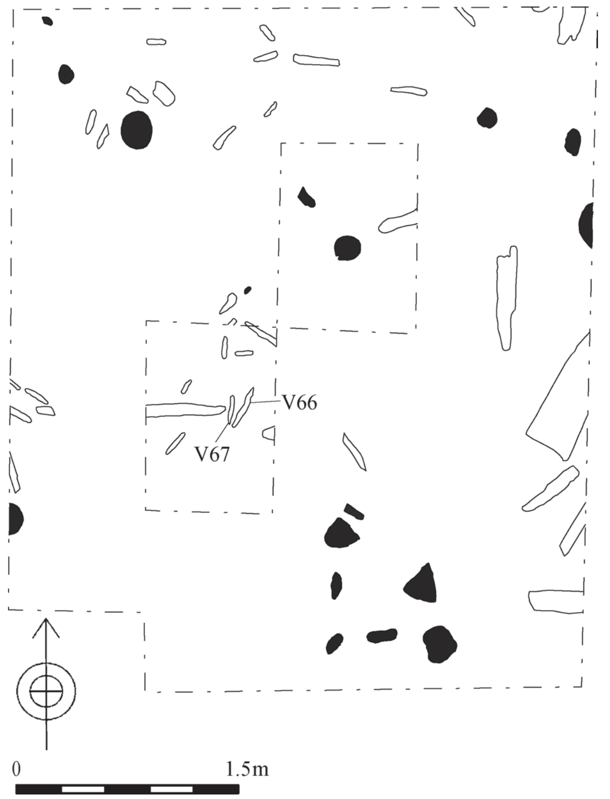


Figure 2.16. Trench 2005/2

course of the excavation period. As discussed later in the chapter, these layers show the archaeological potential of the sub-peat topography and the pre-post alignment deposits, with a growing body of evidence for seasonal movement and inhabitation along the extension of the drier landfalls within the basin.

Trench 2005/3

A trench measuring 5m×3m was opened a further 50m west of Trench 2005/2 (Fig. 2.2). The archaeology within the uppermost layers of this trench appeared to be of a considerably higher quality of preservation than that in the previous trenches, although it was still only considered 'moderate' (grade 3). The tops of five posts were recorded between 0.69m and 0.94m OD, although only one unidentifiable row was observed (Fig. 2.17). A layer of horizontal roundwood and split timbers was exposed and recorded at approximately 0.65m OD in reddish-brown desiccated peat (304), but was not lifted. The presence of additional underlying layers was highlighted through an auger profile where basal deposits of greyish-blue silty sand (305) were retrieved between 0.5m and 0.99m below the exposed layer. Throughout the excavation period the water table was recorded between 0.73m and 0.75m OD, maintaining saturation of the organic deposits, although this was clearly not the case on a permanent basis and this level was well below the tops of the highest vertical posts.

Given the small area exposed in Trench 2005/3, the number of finds from the surface of the uppermost layer (304) was considered to be high, with seven sherds of pottery (SFs120–6, 132), two animal bones (SFs129, 137), three worked flints (SFs128, 131 and 135), a fragment of used quern stone (SF134) and a number of trimmed timbers and wood chips. Future investigation could place the importance of this distribution into a clearer context, but its relative significance lies in its high density by comparison with findspots elsewhere along the post alignment.

Trench 2005/4

A trench measuring 11m×3m opened on the Fengate landfall (Fig. 2.2) exposed the tops of at least four rows of the post alignment between 0.96m and 1.235m OD. The width across the four rows was 6.5m in total, but the character of the rows was markedly indistinct when compared with the rows previously observed along the post alignment, hence making a clear identification of the row numbers very difficult. However, it seems unlikely that Row 1 was uncovered, for in Areas 6 and 8 the posts of Row 1 were

exclusively composed of alder, but in trench 2005/4 only one alder post (V5) was identified, in the second row from the southern limit of the trench. This same row comprised the only real cluster of posts of mixed oak and alder species (V4, V5 and V6), a description redolent of that recorded for Row 3 in Areas 6A and 6B (Pryor 2001, 96, 158–9). This suggests that Rows 2 to 5 were exposed in trench 2005/4.

Three vertical posts (V3, V8 and V94) were removed from Rows 3, 4 and 5 for further analysis. As was found in trench 2005/1, approximately 0.3–0.4m of the post-ends had been very well preserved in the underlying muds and gravels at a maximum depth of between 0.23m and 0.49m OD. These were more heavily encrusted with iron pan and manganese than the posts from trench 2005/1; upon removal, this encrustation was found to have concealed trimmed pencil-like ends.

Two layers of horizontal wood, representing a walkway and underlying foundation, were identified. Taking into account the location of trench 2005/4, on the rising terrace of the fen-edge, the condition of both layers was considerably better than expected, despite being graded either poor or moderate for preservation. Considering the relatively high topographic level of trench 2005/4, this surprising quality of preservation may be explained by the geological deposits of alternating alluvial gravels, sands and silts between the basal peat and Pleistocene gravels. These deposits (407–9, 414–15) resembled a relict watercourse similar to others found at Fengate (C. French pers. comm.), and may have retained a degree of stability in saturation conducive to organic preservation. However, in spite of this organic content, occasional flakes of mineralised wood (up to $40mm^2$), again indicative of oxidising processes, were noted throughout Layers 1 and 2 in the peat (403–4) between 0.855m and 1.095m OD. It is likely that these resulted from fluctuations in a gradually lowering water table, which itself was measured at approximately 0.2m OD during the last two weeks of excavation, almost 0.7m below the horizontal layers of the timber structure.

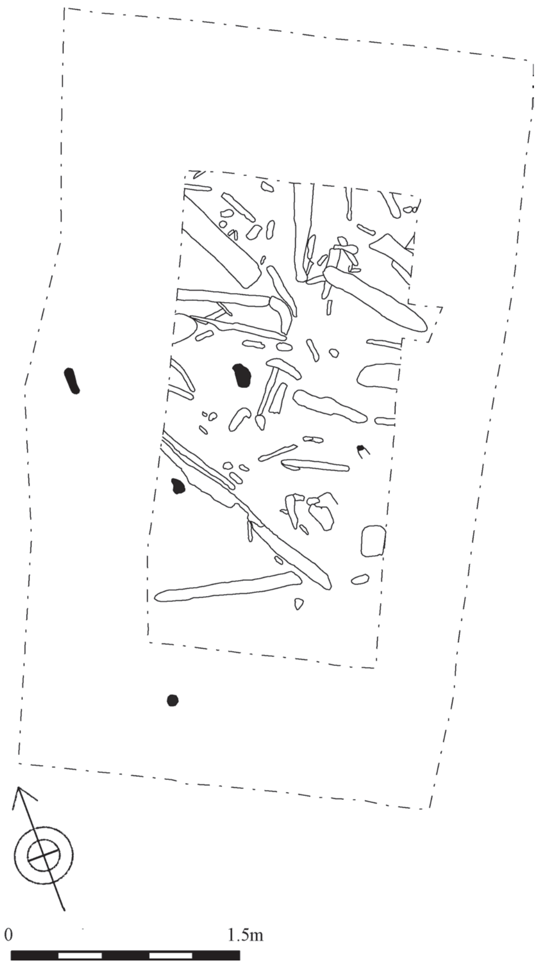


Figure 2.17. Trench 2005/3

Layer 1

The uppermost layer of horizontal wood was encountered at 1m OD (Fig. 2.18). As was found in trench 2005/1, the proportion of wood in Layer 1 was much greater between Rows 4 and 5, with outlying wood to the north of Row 5. Between Rows 4 and 5 a number of horizontal planks, primarily of oak, appeared to form a walkway that had been disturbed, possibly by post-depositional factors. In particular, three split timbers warrant discussion. V15 and V16, both over 2m in length, had broken mortises at each end, with V15 lying on top of and at 90˚ to V16 (Fig. 2.19). V15 may have originally been held in place by two stakes (V20 and V82) angled towards one another, but had somehow become dislodged from their grip. V16, however, with both a broken and a complete mortise, appeared to be fastened at one end by a small peg, but this was later revealed after the complete removal of Layer 1 to be a much larger vertical post (V17) forming part of Row 4, and unlikely to have been used to peg V16 into position. Rather, it is more likely that V16 had drifted into its present position against V17 when maintenance of the structure was nearing an end. Abutting V16 were two sherds of later Bronze Age pottery (SFs57 and 58). Also beneath V15 were a split timber (V91) with a lapjoint almost resting against the southern edge of Row 5, and V87, also with a lapjoint, lying parallel to V16. The dilapidated nature of the structure itself may have been due to its situation at this point of the alignment above a seasonal watercourse. If the timbers had not been reused, then this may explain the damage to the mortises in V15 and V16. However, it is not unusual for the latter stages of the post alignment to display a state of disrepair.

Only a small amount of wood was uncovered in Layer 1 to the south of Row 4, and this was small, fragmentary and poorly preserved. Here, a number of small posts (V18 and V130) or stakes (V10, V11, V12, V14, V19, V143 and V144) formed an S-shaped setting with no indications of wattling or other structural components. The pegging of small wood has been noted elsewhere at Flag Fen,

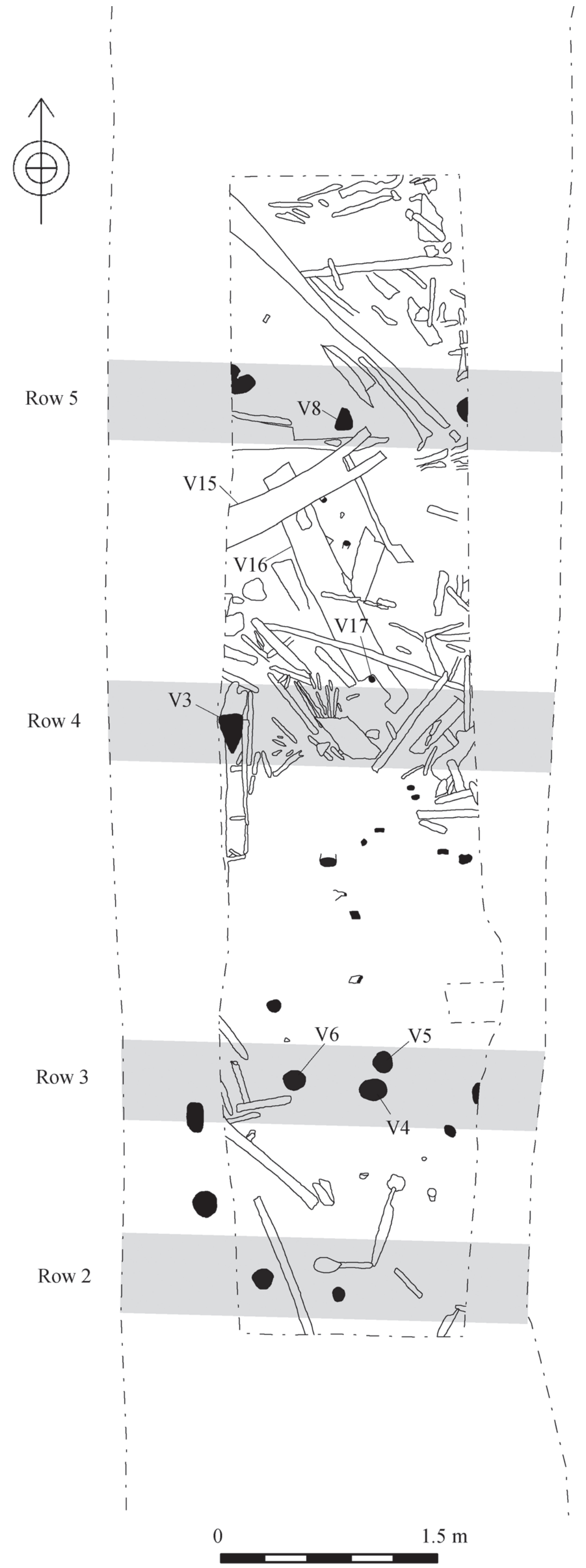


Figure 2.18. Trench 2005/4, layer 1

Figure 2.19. Mortised timbers V16

Figure 2.20. Trench 2005/4, layer 1, occupational debris

particularly within layers of the platform (Pryor 2001, 112). This setting of stakes in trench 2005/4 possibly indicates that structural wood may once have lain between Rows 3 and 4, and had either been washed away, possibly by flooding or rising levels of water within the channel, or had been purposefully removed. Either way, in the absence of wood a deposit of occupational debris, spread from the southern limit of the trench to the north of Row 3, was found in a semi-moist peat with orange mottling (405). This mainly consisted of fire-cracked stones, but also included worked flint (SF42), a bronze pin (SF45), disarticulated bone, sherds of plain Late Bronze Age vessels (SF41 and 43) and a lump of iron tap slag (SF44) (Fig. 2.20). Judging from these finds and their stratigraphic level this appears to be part of a later use of the post alignment from the Late Bronze Age to the Early Iron Age, and may represent a firm walkway between Rows 2 and 3.

Layer 2

At 0.87m OD a second layer of wood rested beneath Layer 1 (Fig. 2.21). Two split oak timbers (V11 and V12) were the

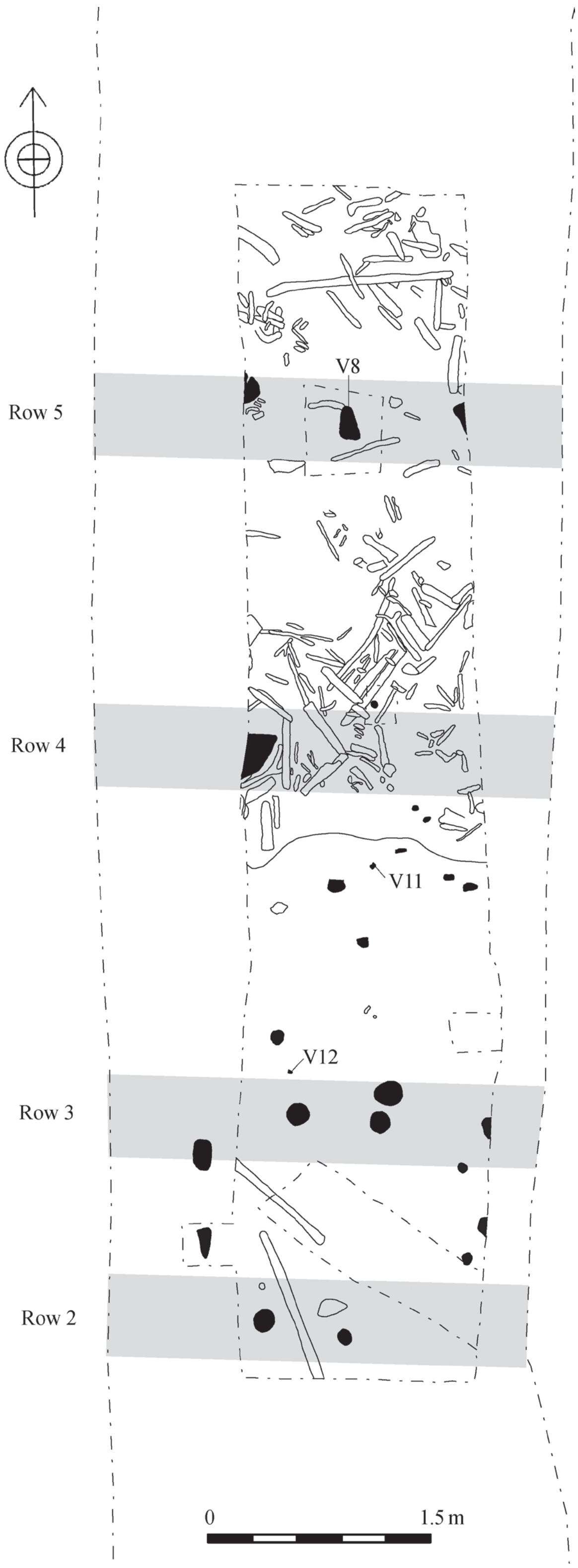


Figure 2.21. Trench 2005/4, layer 2

only wood of this layer revealed between Rows 2, 3 and 4; the wood assemblage was again predominantly found in the area between Rows 4 and 5. It was mainly comprised of a scattering of small split timbers and roundwood, probably as a foundational base for the overlying walkway of Layer 1. Additional pegging was found within this layer between Rows 4 and 5 (V123) and to the north of Row 5 (V129).

In a further comparison with trench 2005/1, the shadow of an additional vertical post (F2) was revealed in section after the removal of the relatively well-preserved vertical post V8 (Fig. 1.4). The profile appeared to be that of an entirely decayed tangentially split post. In section the fill consisted of grainy reddish-brown desiccated wood (418), and at the base the shadow of the pointed tip was represented by a 'doughnut' of indurated manganese iron panning. The implications of this are discussed in Chapter 1, p. 22 above.

Excavations north of the post alignment

Over fifty-five commercial trenches have been opened between 2003 and 2007 within the Flag Fen basin on land immediately north of the Bronze Age post alignment as a requirement of the pre-development planning application process (Cooper 2003; Meadows 2007). In common with the excavations south of the post alignment, the sequence of deposits uncovered followed a general scheme which contained variations in thickness and consistency. At the base of the sequence, the Pleistocene gravels fell from 0.7m OD on the Fengate landfall to approximately 0.1m OD within the basin, and were overlain by a semi- to well-developed palaeosoil of laminated muds and clays capped in turn by an organic peat, a layer of brown alluvial silty clay beneath desiccated peat, and a higher but intermittent post-third-century BC alluvial clay directly beneath the ploughsoil.

A detailed microscopic assessment of the deposits and their archaeological significance or potential is given in Meadows (2007), and represents baseline data for future analysis north of the post alignment. The aim here is to briefly summarise the overall assessment of the condition of preservation of the deposits as a further indication of the basin's analytical potential.

In general pH values were acid in nature, and very high redox values indicated a significant potential for oxidation. Even so, differing degrees of preservation were observed. Where pollen and non-pollen palynomorphs had been preserved they were mainly found to be in a good condition, but the cumulative condition was poor, with a large percentage of damaged grains displaying a high degree of physical and biological damage through exposure to highly oxygenated conditions. Similarly, although only one piece of worked wood was recovered, the preserved natural roundwood present within the peaty layers displayed varied degrees of preservation, although at a surface level this was mainly between the scales of 1–3, *i.e.* very poor to moderate (Bamforth in Meadows 2007). Overall, based on water content values, samples displayed moderate decay in which a well-preserved inner core contrasted with the decayed outer structure (Panter in Meadows 2007). Longitudinal cracks and evidence for microbial decay similarly pointed towards exposure to oxygen concentrations forcing supporting

aerobic conditions. However, whether this was a result of ancient or more recent exposure could not be ascertained. It was concluded that the wood had 'undergone typical heterogenous decay with zones of soft decayed wood intermingling with zones of less decayed wood' (Panter in Meadows 2007, 87). Overall, this evidence confirmed assumptions that the primary archaeological activity within the Flag Fen basin lies to the south of the Bronze Age Post alignment, and that a process of degradation appears to be ongoing within these delicate deposits.

Discussion

The seventy-plus trenches opened within the vicinity of the western stretch of the Flag Fen post alignment since 1997 demonstrate that there is a great variety in the type and thickness of the geological strata across the study area. Ongoing developer-funded research led by the Cambridge Archaeological Unit and its associates is gradually mapping these deposits throughout the Flag Fen basin, building a picture of a complex network of intercutting channels, ponds and landforms. The most striking of the geological features described here are the channel following the contour of the Fengate landfall and the projection of naturally raised gravels from Fengate towards the centre of the post alignment. These are explored further below. The site's hydrological pattern as a whole appears to be characterised by variable degrees of saturation and preservation over time, with the most recent excavations indicating that the current state of the organic deposits across the post alignment is inconsistent. This immediately presents a problem for interpretation where more recent natural processes of degradation cannot easily be separated from ancient natural and human agencies that once impacted upon the character of the site. However, a number of statements that offer new perspectives on the evolving biography of Flag Fen are still possible.

Pre-post alignment activity within the Flag Fen basin

Activity that pre-dates the construction of the post alignment at Flag Fen has, in terms of discussion, generally been confined to the dryland masses of the Fengate and Northey shorelines. It has been postulated that Neolithic activity is concealed within the basin itself, although the lack of a formal droveway or monumental marker on the dryland has reified doubts regarding the nature of Neolithic settlement (Pryor 2001, 406–7). Indeed, Neolithic settlement along the fen-edge of the Flag Fen basin has not been clearly elucidated from either a wider Neolithic landscape or separate landscapes with shifting dwelling patterns or 'settlement drift' (Pryor 2001). Such absences have supported a conception of the basin as a boundary or way-marker. However, recent finds at 0m to 0.25m OD of redeposited gravels and substantial assemblages of Grooved Ware and Beaker within the Edgerley Road site, King's Dyke and Bradley Fen – *i.e.*, along the northern and southern fringes of the Flag Fen basin – are beginning to expose an early, albeit limited, use of and movement within the basin among the channel flows and along subtle topographic undulations (Beadsmoore 2005; Gibson and Knight 2002; 2006; M. Knight pers. comm.). The fen-edge has subsequently been identified as a location for 'task-scape' activities (Evans 2009: 112).

It is for this reason that the basal deposits found in trench 2005/2 are of particular significance. Lying between -0.05m and 0.08m OD, these low-lying silty deposits seem to indicate an alternating environment of slowly flowing and shallow standing water upon a deflated peaty surface (C. French pers. comm.). The association of these deposits with flint tools and worked wood suggests an early passage point similar to those mentioned above. This is a clear indication of the potential for finding additional well-preserved signs of human activity that significantly pre-date the post alignment and platform, and may also give greater depth to the importance afforded the Flag Fen post alignment as a marker of the significance of the basin itself.

Evidence for a second pre-post alignment feature is possibly represented by the timber found to the south-west during STW 2003 (Fig. 2.2). It remains unclear whether these timbers were purposefully laid or if they were fen carr scattered within an inlet, but while it is difficult to assign the status of trackway to these timbers it should be noted that more obvious ephemeral trackways have been recorded elsewhere in the Flag Fen basin. The nearest example is that of the poorly preserved trimmed horizontal timbers and roundwood laid in a parallel arrangement abutting the Northey landfall, which were found during excavations prior to the construction of the Visitor Centre (Chapter 3, this volume). However, this arrangement was not secured by stakes or a underlying foundation, and has been likened more to a pier than a trackway. Alternatively, a more robust example was found at the Silt Lagoon of Bradley Fen, one kilometre to the south of the post alignment, where a stake and brushwood trackway dating to the Middle Bronze Age had been constructed on a raised bank, weaving across a wooded landscape towards Fengate and roughly in the direction of the STW 2003 timbers on a north-west–south-east axis (Gibson and Knight 2006). On the basis of these examples a similar hypothesis for the timbers excavated in 2003 should not be discounted.

The Bronze Age post alignment

A number of preliminary statements can be made regarding the western stretch of the post alignment in terms of its structural character, foci of activity and preservation. First, it is immediately obvious in plan view that the post alignment does not follow a straight course between the landfalls of Fengate and Northey via the platform; there is a somewhat abrupt change of direction to the north approximately 60m west of the platform edge (Fig. 0.2). The reasons for this are not clear at present, but, as Francis Pryor suggests in Chapter

9, it may emulate the architectural passage of movement found in other monumental forms, often taking into account landscape features of ancestral importance. It may also be of significance that the point at which the post alignment alters in its course is near to the undulating drift geology that could be observed in trench 2005/1 and STW 2000 as naturally raised gravels projecting into the basin from the Fengate landfall. The significance of this 'feature' for earlier communities along Fengate is still unexplored, but further investigation into its extent and its relationship with the post alignment and platform is clearly warranted.

All five rows of posts clearly continue their alignment from the platform through the western stretch of the basin towards the Power Station excavations at Fengate (Pryor 2001). Row 1 was not exposed in any of the 2005 trenches, but its presence may be inferred from the identification of Rows 2 to 5 and their typological similarity to rows recorded elsewhere along the post alignment. The post alignment therefore follows a regular pattern throughout the embayment before drifting from its conventional form into a much less distinct character as it rises against the Fengate landfall. A similar pattern is observed in Chapter 3 for the Northey landfall.

Up to three distinct layers of horizontal wood representing two constructional episodes were identified in 2005. These layers reached their highest grade of preservation in trench 2005/1. This may be due in part to the relative depth of the deposits in trench 2005/1, resulting in greater saturation of the deposits. However, the three layers were found only between Rows 4 and 5 in trench 2005/1, with two layers identified in trench 2005/4, and the conditions of preservation being too poor in trench 2005/2 for any distinction between layers. Layer 3 was the earliest of the exposed layers, with moderately sized trimmed wood forming a possible walkway. Above this, Layers 1 and 2 may be regarded as contemporary, with Layer 2 acting as a foundation composed of small fragmentary roundwood for the larger split timbers of Layer 1 above. The larger timbers in Layer 1 may have formed specific walkways, although the small size of the evaluation trenches, combined with differential preservation in each trench, makes certain identification of walkways somewhat difficult. It may also be that the structure of walkways along the western stretch of the post alignment is different to that observed in previous excavations further east. Nonetheless, it has been suggested here that walkways were found in both trenches 2005/1 and 4 in a dilapidated state between Rows 2 and 3, and also between Rows 4 and 5. Again, this corresponds with observations made during previous investigations.

It is notable that a number of the larger mortised timbers from Layer 1 had already been utilised for structural purposes prior to their incorporation within the post alignment. The reuse of timber has been observed elsewhere at Flag Fen (Pryor *et al.* 1986; Pryor and Taylor 1993), and the general association of larger timbers with the later phases of construction at Flag Fen (Pryor 2001, 104) is confirmed with Layer 1 on the western stretch of the post alignment. As Pryor (2003, 297–302) has noted elsewhere, the deposition of fragments of wooden boats and carts in timber causeways may have had great symbolic significance, imbricating notions of craft expertise, exchange, mobility and even death. It may be that the incorporation of structural fragments from other aspects of the Bronze Age world were equally symbolic, particularly when made of oak (Chapter 9, this volume), possibly even acting as an alternative means for marking the end of a transaction or relationship of some kind, as Bradley and Ford (2004) have recently suggested for the deposition of two fragments of a single bronze sword at separate, yet intervisible, locations 3km apart in Staffordshire.

There is sufficient evidence remaining at Flag Fen to chart the lifecourse of the post alignment, with its final stages being represented by a spread of burnt stones, iron tap slag and other occupational debris upon Layer 1 to the south of Trench 2005/4 between Rows 1 and 3. A similar deposit of burnt stone and related debris of Iron Age date, interpreted as an 'occupation spread', was uncovered with a nearby post-built structure south of the post alignment at the Depot Site on the cusp of the fen-edge (Evans and Pryor 2001, 24). The surface spread upon the post alignment may represent similar activities, but with a final purpose more akin to a dry footing over an otherwise wet watercourse and unstable walkway. In either case, this surface spread is indicative of the continued use of the alignment into the Iron Age.

Conclusion

Combining data from intrusive and non-intrusive investigations into the current and changing nature of the burial environment at Flag Fen has provided a baseline that presents ongoing and accelerating processes of degradation of the organic archaeological deposits (Fig. 2.22). Variation in the preservation quality of these deposits is the result of a number of factors, explored in Chapter 1. What is clear from the excavations presented here is that the complexity of the geological profiles across the study area further corresponds with the variation in preservation quality, which ranges from very poor to a grading of 'moderate', or what may be regarded as the borderline of meaningful analysis. In spite of this, these small-scale investigations have shed light on a stretch of the alignment that has previously been under-explored.

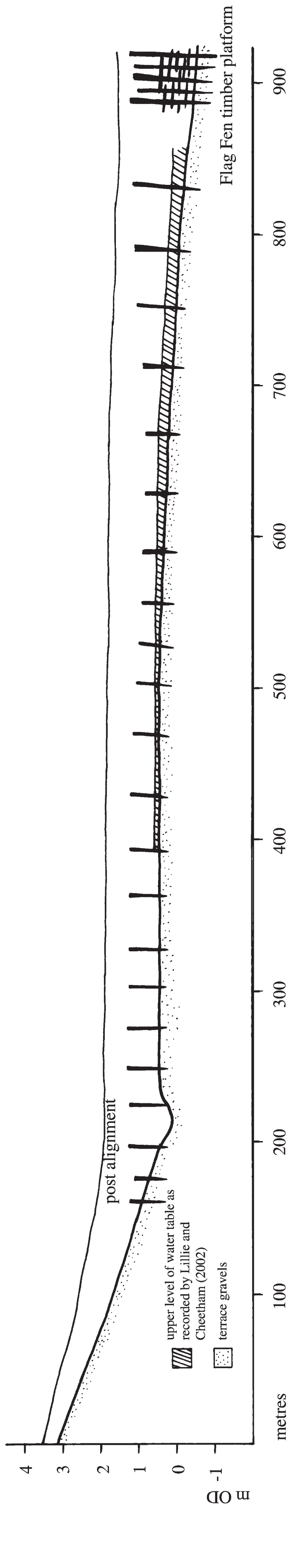


Figure 2.22. Section profile of Fengate landfall and basin, including the results of the watertable monitoring program (After Pryor 2001 fig. 1.7: 9)

3. Excavations Towards the Northey Landfall

David Britchfield

Introduction

This chapter will focus on the interface of wet and dry deposits towards the eastern end of the post alignment at Northey. Initial research took place as part of two PPG-16 projects which were commissioned in advance of the construction of a new access road and Visitor Centre for Flag Fen. The work was funded through the Millennium Commission and Peterborough Environment City Trust, who were co-ordinating construction of the 'Green Wheel' cycleway around Peterborough. Two archaeological projects, described below, arose from these developments: Northey Excavations and the New Visitor Centre Excavations. In addition, *Time Team* Excavations (carried out in 1999) and Fenland Archaeological Trust training and outreach excavations, which were privately funded by Anglian Water in 2003 and 2004, are also included.

The Flag Fen basin: the setting and recent research

This report is primarily concerned with the northern part of the Flag Fen basin. Here the underlying natural subsoil is first terrace Nene gravel, which is overlain by a series of superficial water-borne Flandrian deposits mainly of peaty alluvium (French 2001, 400–4; Horton *et al.* 1974). The basin is entered from the open Fens to the north-east by way of a kilometre-wide 'strait' of regularly flooded land, which was traversed from the Middle Bronze Age to the end of the Bronze Age by the Flag Fen post alignment. Thereafter the site of the posts was regularly visited – and numerous 'offerings' were made – until late in the Iron Age. This setting of posts may have acted both as a barrier against access from the open fen to the north and as a means of crossing the strip of wetter ground; it also played an important ritual role (Pryor 2001; Pryor *et al.* 1986). The landscape of the western, or Fengate, landfall has been the subject of archaeological investigation for much of the past century (Abbott 1910; Leeds 1922; Hawkes and Fell 1945; Pryor 1974; 1978; 1980; 1984). The eastern, or Northey, landfall has been briefly discussed in the English Heritage Flag Fen Basin report (Pryor 2001, chapter 7), is also considered by Hall in his volume on 'Peterborough to March for the Fenland Survey' (Hall 1987, Thorney parish 48–54), and formed an important component of the English Heritage South-West Fen Dyke Survey (French and Pryor 1993, 92–100).

The Northey landfall

The Fengate 'shore', the western landfall of the post alignment, slopes very gradually from west to east. This contrasts with the situation to the east. Here the underlying first terrace gravels slope much more steeply and the land surface of the Northey 'island' (in actual fact a stubby north-west 'headland' of the much larger Fen 'island' of Whittlesey) is slightly higher than Fengate. It is possible that the sinuous Mustdyke (or Padholme Engine Drain) may follow a natural stream channel that could have eroded the underlying gravels, perhaps in early post-glacial times. Whatever the cause, the slope is notably steeper and deep deposits of wet peats are encountered much closer to the dry-land edge than at Fengate. Pollen analyses from sample columns immediately east of the Mustdyke show a largely aquatic flora and there is also evidence for shell marl – a naturally occurring lakebed deposit (Scaife 2001).

The Fengate area is characterised by the widespread occurrence of a well-preserved palaeosoil beneath thick accumulations of alluvium. At Northey, on the other hand, the buried soil is well preserved in those places where there are deposits of alluvium, but on the higher ground (mainly east of Northey Road) it is either thin, wholly incorporated within the modern ploughsoil, or absent. The soils, pollen and stratigraphy of the Northey landfall have been considered at length by French and Scaife in the Flag Fen Basin Report (Pryor 2001).

The aerial photographic survey

Introduction

A reappraisal of aerial photographs of fenland east of Peterborough was long overdue, as there have been many good summers for the production of cropmarks since the publication of the Royal Commission's report on Peterborough New Town (RCHM 1969). Accordingly, Rog Palmer, of Air Photo Services, was commissioned to review the aerial cover of Fengate and Northey from OS NGR TL2098 to TF2400 as part of the archaeological assessment of the Green Wheel cycleway project. The results have been published as a clients' report and any photographs consulted have been listed (Palmer 1999). The present account is based on extracts from that report. Photo interpretation was carried out at 1:2500 level but was rectified using control taken from the OS 1:10,560 edition (1958), which showed most of the field boundaries recorded on the pre-excavation (1970s) photographs.

The survey resulted in two maps of cropmarks: the area (Fengate to Northey) as a whole, mapped at 1:10,000 (Fig. 3.1) and the stubby 'headland' of Northey at the eastern landfall of the Bronze Age post alignment and the Fen Causeway Roman Road, mapped at 1:2,500 (Fig. 3.2). The former was subsequently subdivided into three period-based maps (Fig. 3.3, 3.4 and 3.5).

Soils

The Soil Survey of England and Wales (SSEW 1983) shows the high ground of Peterborough and Northey to be separated by a tongue of river alluvium over peat (series 813a). Peterborough is mapped as 'urban', while Northey is the most western part of Whittlesey island and comprises river terrace drift (series 573a). More detail is given by Hall (1987) and Pryor (1992), but it is relevant to note that both areas of high ground are gravel deposits on which the soil fills in once-cut features (natural and man-made) are easily able to affect crop growth and thus may be recorded from the air.

Archaeological features

It is somewhat surprising, and perhaps a reflection on the cost-effectiveness of aerial survey, to note that initial recording of what has become the Fengate field systems and adjacent enclosures was made by means of less than a dozen oblique photographs on three dates in 1960, 1961 and 1962. Work for this project began with those photographs and has added other details that were recorded on obliques taken during excavation and from routine vertical surveys. No use has been made of photographs taken of excavations which would enable the addition to the map of fine detail (such as hut circles) which rarely affect crop growth and thus are not commonly identified on archaeological obliques. Initial recording of Northey noted the soil-mark evidence of a length of the Fen Causeway with, nearby, what was suggested to be a temple (Hall 1987). Later photography recorded cropmark features that include fields, domestic enclosures, ring-ditches and a probable occupation area. The survey has revealed a number of new features of interest which are considered in greater detail below.

Fengate

The area of Fengate that was mapped is slightly greater than that usually identified as 'Fengate' (*e.g.* Pryor 1998a, Fig. 42) and includes features to the west and north on which no archaeological investigations were undertaken before Peterborough expanded over them. One area to the south (centred TL212985) was more recently excavated by the Cambridge Archaeological Unit following an assessment of the few aerial photographs recording that single modern field (Palmer 1999). Other recent developer-funded assessments of aerial photographs within the mapped area identified no archaeological features.

New information has been mapped in two locations on the landward side of the Fengate–Storeys Bar Road circuit. One, centred TL209985, includes some uncertain features but is of similar appearance to the excavated field and drove systems. Other traces of ditches further north (centred TL217998) are less cohesive in appearance. These, and most of the other lesser lengths of ditch, were identified on vertical photographs at the National Library of Aerial Photographs which had not previously been examined.

Evidence was sought for the Fen Causeway on the high ground, but no trace or suggestion of it was seen. In two areas traces of what appears to be ridge and furrow were found with one apparently including a headland (TL212991).

The Fen Causeway

The course of the Roman road known as the Fen Causeway was visible where it crossed the gravel of Fengate, and again crossing Northey (Fig. 3.5). In places, on first terrace gravels at Fengate, side ditches were evident. The forking of the road north of the Power Station was very clear on early vertical photographs and is similar to that at Grandford, on March island to the east. It could be suggested that this local diversion was made to bypass the earlier route, which may have been made unacceptably boggy by wear and changing water levels. However, recent excavations have proved beyond doubt that the short additional length of 'road' is in fact a spread of post-medieval rubble complete with sherds of modern glass (Meadows 2007, 3). The genuine road can be traced towards Northey as a series of short straight lengths, which were presumably following a local ridge (in fenland terms) or firmer ground. The closeness of the course of the Roman road to the post alignment suggests that the latter may have helped to direct this route some 1000 years later. In a waterlogged or seasonally flooded environment it is possible that the line of posts would have

A : Site 11 (Pryor, 1993)
B : Third Drove (Evans, 1992; 1993; Pryor 1997a)
C : Tower Works (Lucas, 1997)
D : Ditched Enclosure
E : Ditched Enclosure

Figure 3.1. Location plan showing principal areas discussed in the text and Fengate to Northey: map of cropmarks revealed on aerial photographs

Figure 3.2. Northey: map of features revealed on aerial photographs

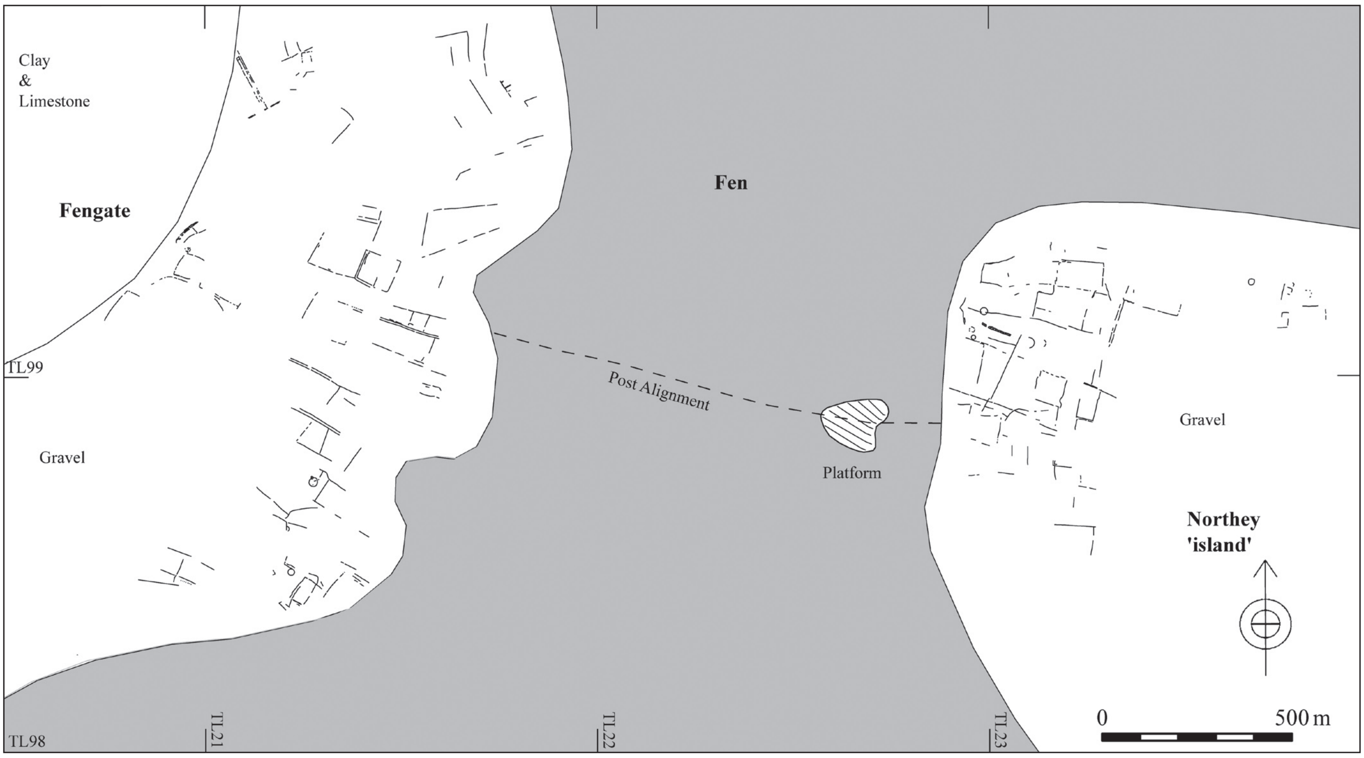


Figure 3.3. Map of probable Bronze Age features

Figure 3.4. Map of probable Iron Age features

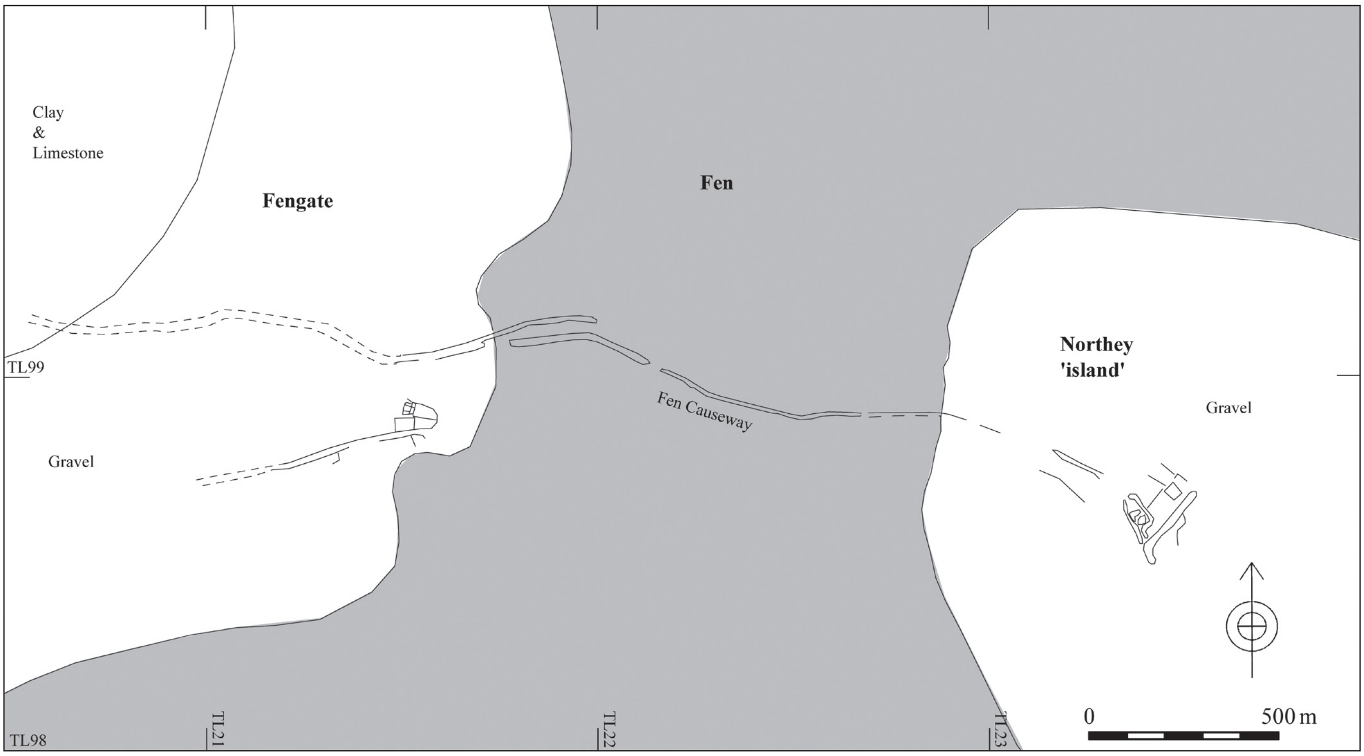


Figure 3.5. Map of probable Roman features

created a visible linear ridge which the route of the Fen Causeway utilised.

The Fen Causeway continues its angular course across Northey Island and appears to form part of what may be a roadside structure just before the present course of the Nene. Features here were identified on vertical photographs taken before quarrying destroyed the site. The prints were relatively small-scale but showed a number of dark patches – most probably quarry pits – surrounded by lighter-toned 'banks', one or all of which seem likely to be part of the Fen Causeway's construction.

Northey

The map combines information on the area around Northey that was recorded over several years, although there remain a number of fields on the high ground that have never been photographed under responsive crop or soil conditions. Initial focus was on the 'temple', which showed as a ditched rectilinear enclosure with internal bank and a near-central light-toned area that is likely to indicate either a mound or structural remains. When photographed under crop, neither the bank nor the internal mound show up (this is usual in such situations) but there are internal features, including an arc of ditch, that do not respect the central lighter area. Thus there may be more than one phase of activity within the enclosure.

Under crop, the 'temple' can be seen to be one component of a network of ditched features. Some, on the highest ground, form what appears to be a system of large rectilinear fields with at least one integral droveway. One axis of this is parallel to the adjacent length of the Fen Causeway. Traces of other possible fields cross, or are crossed by, the Fen Causeway and are set on similar axes in the triangle of ground formed by the River Nene and Mustdyke. Various pits and other features identified in the Dyke Survey may relate to these fields (French and Pryor 1993, 92–6).

East of the well-recorded features, one field was photographed in responsive conditions on an Ordnance Survey sortie and shows short lengths of ditch and other features. Ditch alignment is similar to that to the west and suggests that the ditched fields may once have covered at least twice the area currently recorded.

Two adjacent enclosures are mapped at TL232990. Both show internal and external pits, the form of which suggest usage for occupation. Small paddocks are attached and the alignment of these and the two enclosures match that of the surrounding fields.

North of the 'temple' is an area of small ring-ditches (not all of which are round) in an area which shows as disturbed ground. It is not clear whether this results from natural or human causes but, taken with the small ring-ditches, it suggests a possible area of unenclosed occupation close to the edge of the island.

Flanking the west side of the island are two bands of deeper soil that join to the north. One of these may show an earlier course of the Cat's Water while the other may result from soil accumulating along a fen-edge or, as is

known from elsewhere in the fens, may show a watercourse that once skirted the edge of the island. The date of these cannot be determined from the aerial photographs but they may offer areas within which archaeological features may be better preserved.

A number of non-archaeological features, such as periglacial cracks, have been recorded at Northey. Where possible these are identified as such on the basis of, usually, their broader width and irregular course, but some may have been mapped here as 'archaeological'. Two small areas of hand-dug quarrying are mapped on Northey and the progress of the more extensive quarrying on the south flank of the island is noted in working documents.

Discussion

Rog Palmer's survey has thrown some interesting new light on one or two problems which have arisen out of the original (1971–78) Fengate project and subsequent research. We will consider them in chronological order below.

The main components of an earlier Neolithic landscape were first identified in 1988 (Pryor 1988). The problem was revisited in 1993 and on subsequent occasions (Pryor 1993; 1998a, 73–81); the recent discovery and excavation by Cambridge Archaeological Unit of a possible funerary or mortuary structure near the Cat's Water extended this early landscape to the extreme edge of the then-developing fen (Pryor 2001, chapters 2 and 18; Gibson 1998). When the components of this landscape were mapped, there was something of a gap between the Site 11 enclosure and the paired ditches of the possible earlier Neolithic droveway at Vicarage Farm, to the north-west. The new survey, however, reveals yet another pair of parallel ditches just under 100m north-west of the rectangular Beaker enclosure known as Site 11 (Fig. 3.1: A). These may represent a continuation of the 'main' droveway defined by Bronze Age ditches 8 and 9, but their orientation differs significantly from that of the field system as a whole and is almost identical to that of Site 11, which, moreover, they appear to be respecting. If this new drove can indeed be accepted as early, then it provides additional evidence to suggest that the early open landscape may originally have developed along a cleared and regularly travelled route.

The Flag Fen Basin report suggests that the Fengate Bronze Age fields, while undoubtedly part of the same system, could be subdivided into three broad areas: south, central and northern (Pryor 2001, chapter 18). Again, the survey provides evidence to support the tripartite arrangement and it throws light on the different character of fields in each of the areas.

The southern fields are not laid out on the basis of regular partitioning droveways that run down to the fen at right-angles. Instead, they are smaller and seem to have developed in a less co-axial, more 'organic', fashion. This is particularly true of the fields south of Third Drove, which have been the subject of two recent excavations (Evans 1992; 1993; Pryor 1997a) (Fig. 3.1: B). Some 300m to the WNW are traces of fields associated with the Tower Works site (see also Lucas 1997). Interestingly, these do show some evidence for a larger partitioning style of droveway which appears to be running at right-angles to the fen (Fig. 3.1: C). Excavation to date would indicate that the southern fields began later than their counterparts in the central area (possibly in the Middle Bronze Age), but they may have continued in use into Early Iron Age times, as witnessed by the pit groups from the old Gravel Pits Settlement Area. The location of individual finds and features within the pre-war Gravel Pits Settlement Area was never precisely tied down, but the hand-dug gravel pits in question occurred over an area of 625 (E–W) by 440 metres (N–S) immediately south and east of the junction of the Car Dyke with Padholme Road. (Hawkes and Fell 1945; RCHM 1969, Fig. 1).

Recently, as groundwater tables continued to drop, archaeological attention has been focused on the wetter parts of the landscape and particularly on the wet/dry interface. This has meant that the 'inland' or landward boundary of the Bronze Age field system has tended to be ignored. On the drier land, two to three hundred metres east of Car Dyke are two ditched enclosures of roughly rectangular shape (Fig. 3.1: D and E). These are probably Iron Age and belong with the long-lived settlement whose eastern edge was excavated on the Vicarage Farm sub-site (Pryor 1974, 15–22; 1984, 7–10). Immediately south-west of the two enclosures is a series of ditches on the alignment of the Bronze Age field system which seem to branch off a droveway, aligned more or less on the course of the eastern length of Padholme Road. Perhaps this droveway is a westerly continuation of a droveway formed by ditch 5 (Pryor 1980, Fig. 5).

The main interest in the westerly extension of the field system lies in the way that the droveway described above ends. It appears to give on to open land to the west, the ditches on either side swinging away to the north-east and south-west in precisely the same way that the ditches of the 'main' droveway (defined by ditches 8 and 9) turned outwards and ran along the edge of the regularly flooded land at the point where that droveway gave way to the post alignment on the Power Station site (Pryor 2001, chapter 4).

If the arrangement of ditches just described does indeed mark the western limit of the Bronze Age field system, it would mean that the fields were confined to the strip of first terrace gravels that ran along the fen margin. The western limit suggested here coincides with an outcrop of cornbrash limestone and heavier clay land. The north and south limits of the field system are not yet known, but the central element is approximately a kilometre in width.

The northerly element of the field system can now be seen to extend at least a kilometre north of the 'main' central drove (defined by ditches 8 and 9). Detail is patchy and at times obscure, but the fields appear to be somewhat larger than those of the south and central elements of the system and the regularly spaced pattern of droves is not immediately apparent. Excavation in the northern part of Fengate has revealed extensive evidence for Beaker and Early Bronze

Age settlement associated with field boundary ditches (Pryor 2000a; Vaughan and Trevarthen 1998). These excavations – and other smaller projects and watching briefs – suggest that the apparent 'sketchiness' of the field boundary ditches reflects the thick alluvial cover in the area (Pryor 1997b). In reality the northerly fields are likely to be as complex as the rest of the Fengate system.

It is interesting to note that one of the Iron Age enclosures (Fig. 3.1: E) located to the east of the Car Dyke resembles a stockyard (Pryor 1996). It has a wide and slightly flared corner-entranceway which faces away from the lighter gravel land towards the open cornbrash and clay landscape to the west. We will consider the significance of this at the end of the chapter.

The seeming 'disappearance' of the Roman Fen Causeway west of Storey's Bar Road needs to be explained. The recent reassessment of the aerial photographic evidence suggests that it most probably follows the course of Padholme road, whose slight change of direction just before OS grid 21 Easting (Fig. 3.1) picks up the Fen Causeway's change of alignment a kilometre to the east. This course would broadly confirm that suggested by the Royal Commission (RCHM 1969, 39–40).

Recent excavations at Northey: 1. Introduction

The three principal projects towards the Northey end of the post alignment were all ultimately associated with the construction of the Millennium Commission Green Wheel cycleway. The Green Wheel is a continuous route which encircles the City of Peterborough and has involved the construction of several major structures, including a new steel bridge across the River Nene approximately a kilometre to the south-east of the Flag Fen archaeological site. At Flag Fen the cycleway skirts the archaeological site along its eastern periphery, following the approximate junction between wet and dry ground in the Bronze Age. As part of the Green Wheel project Flag Fen has acquired a new access route, off Northey Road to the east, and a New Visitor Centre, whose circular design echoes a Bronze Age turf-roofed roundhouse. The first archaeological response to the new development was the aerial survey described above. The route of the cycleway was evaluated and excavated between February and September 1999 as part of Northey Excavations, which were carried out by Soke Archaeological Services Ltd (at that time the archaeological contracting company of the Fenland Archaeological Trust).

The various components of the Green Wheel project were augmented in May 1999 by a short excavation carried out by Channel 4's *Time Team*, which investigated the preservation of the post alignment west of the cycleway and carried out an evaluation of a partially destroyed round barrow immediately east of Northey Road. The *Time Team* project is described later in this chapter, along with evaluation and excavation ahead of the construction of the New Visitor Centre in the autumn and winter of 2000. Finally, the last section of the chapter focuses on university training excavations carried out in 2003 and 2004, which targeted the periphery of archaeological features identified during the Green Wheel and *Time Team* excavations in 1999.

A general map of archaeological trenches associated with all projects is given in Fig. 3.6. The numbering system used on site utilised the standard cut and fill symbols – *i.e.* cuts were recorded in square brackets [number] and fills in round brackets (number). For ease of reference these have now been designated a feature number (*e.g.* F34). Owing to the density of archaeological features encountered, the main focus of the text will deal primarily with key features and their associated characteristics.

Recent excavations at Northey: 2. Green Wheel excavations (1999)

Introduction

Prior to the development of the Green Wheel cycleway and the access road to the New Visitor Centre, an archaeological strategy was arranged with Ben Robinson of Peterborough City Council Archaeology Service in advance of any formal planning application being made. Initially it was agreed that four trenches (NT1–4: see Fig. 3.6) be excavated along the proposed route of the Green Wheel. However, in order to supplement existing archaeological knowledge of the Northey landfall and provide further information prior to archaeological mitigation being agreed, it was decided that a preliminary low-impact investigation was required. In the summer of 1999 a series of test pits was excavated to confirm not only the potential presence of archaeological material but also the existence of possible palaeochannels. Twelve test pits positioned in order to gain an overall insight into the levels of archaeological disturbance were excavated along the route of the proposed cycleway (Fig. 3.7).

Preliminary investigations (1999)

A common stratigraphic deposit model (CSDM) was recognised across the site as a whole (Fig. 3.8 and 3.9). It comprised topsoil (001) overlying peaty alluvium (003) and a buried soil horizon (005). On occasion, however, variations occurred. Deposits within Test Pit (TP) 5, for instance, proved to be slightly deeper than those within the immediate vicinity. This was caused by the formation of an additional layer of desiccated peat (004) similar to (003), albeit subject to more extensive dewatering. It is possible that deeper peat deposits such as those recorded within TP5 may be evidence for the suggested palaeochannel, but this could not be demonstrated. The same could be said of similar deposits in TP4, which had been positioned to test the presence of a palaeochannel running approximately north–south across the site, a feature suggested by Palmer (1999). Excavation penetrated to a depth of approximately 0.7m, where the buried soil horizon (005) was encountered. No archaeological features were visible at this time, so layer

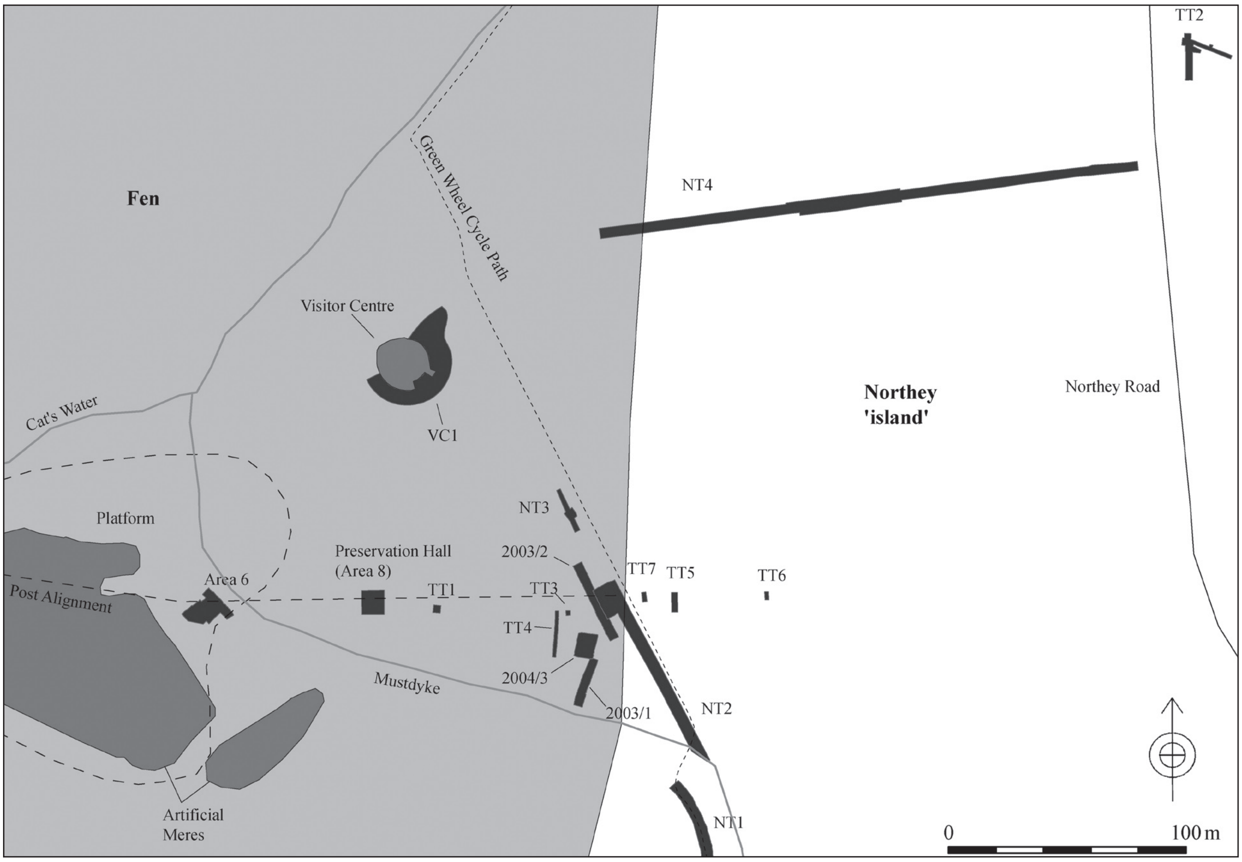


Figure 3.6. Investigations to the east of the timber platform, in the vicinity of the Northey Landfall

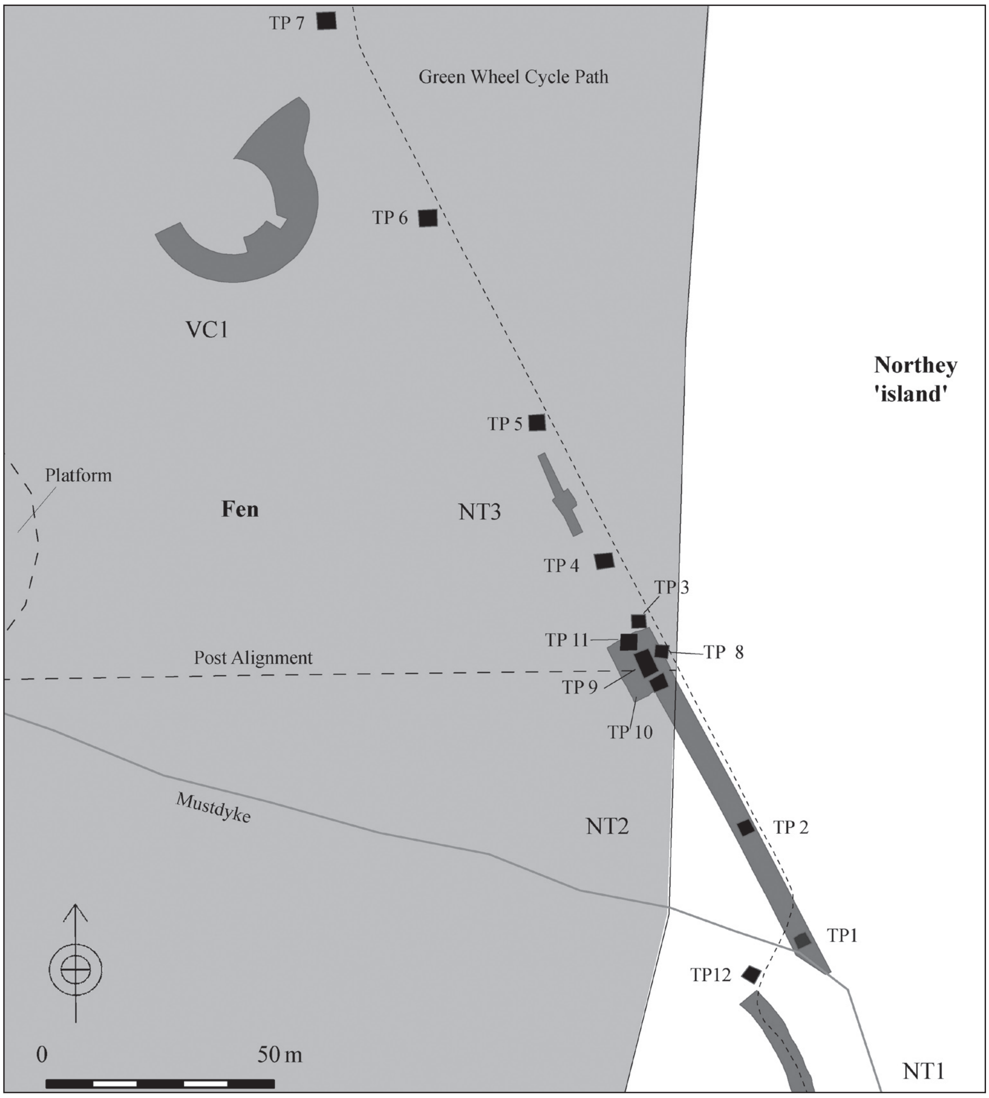


Figure 3.7. Position of test pits TP1–7 prior to the excavation of trenches NT1–4

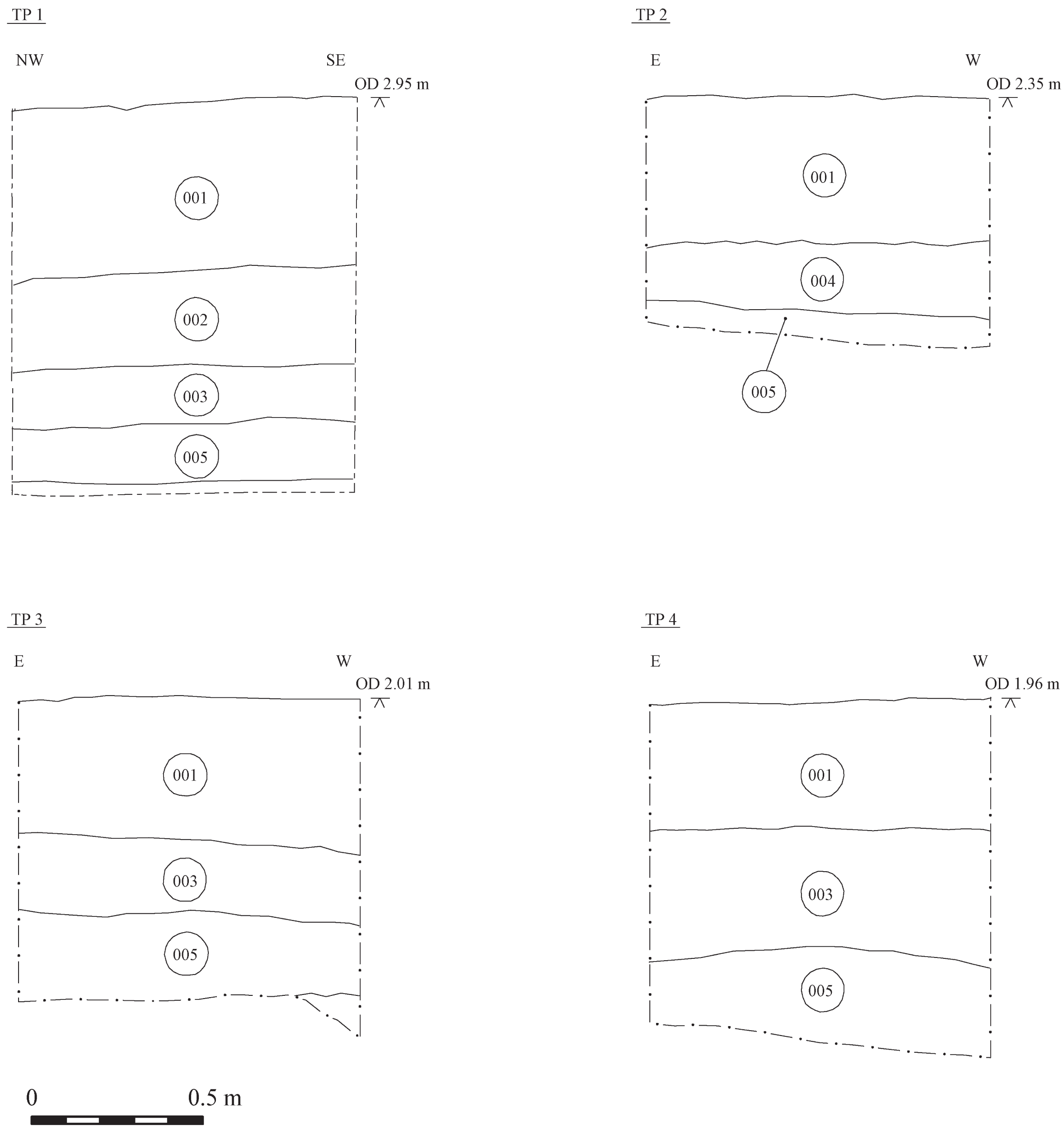


Figure 3.8. Green Wheel test pit profiles TP1–4

(005) was dug by hand until natural gravel was reached. This layer was only 0.25m in depth and was thus somewhat at variance with the predicted existence of a deep alluvial palaeochannel. Further additions to the common stratigraphic deposit model include a layer of redeposited gravel (002) recorded within TP1. Such deposits are common alongside drainage ditches, being formed of the upcast produced by the regular cleaning-out of dykes in the autumn so that they can cope with the heavier rains of winter.

Two test pits warranted closer attention, as they threw new light on Ditch 1 of the original Fengate system (Pryor 1980, 7). TP8, which was excavated to a depth of 1.3m, revealed deeper layers of peaty alluvium (003) and buried soil (005). A thin horizon of dark silt capped an underlying ditch (recorded as [012]), the filling of which comprised two silty gravel deposits (010 and 011) which were thought initially to represent the targeted palaeochannel. Subsequently it has been shown that this feature was part of the Bronze Age landscape associated with the Northey landfall (see below). In addition, TP12 revealed that some prehistoric wooden posts survived; there was also a very dense distribution of potential stake-holes, post-holes and pits, as well as a second extension to the previously recorded Fengate Ditch 1 (recorded as [008]) in the underlying gravel natural.

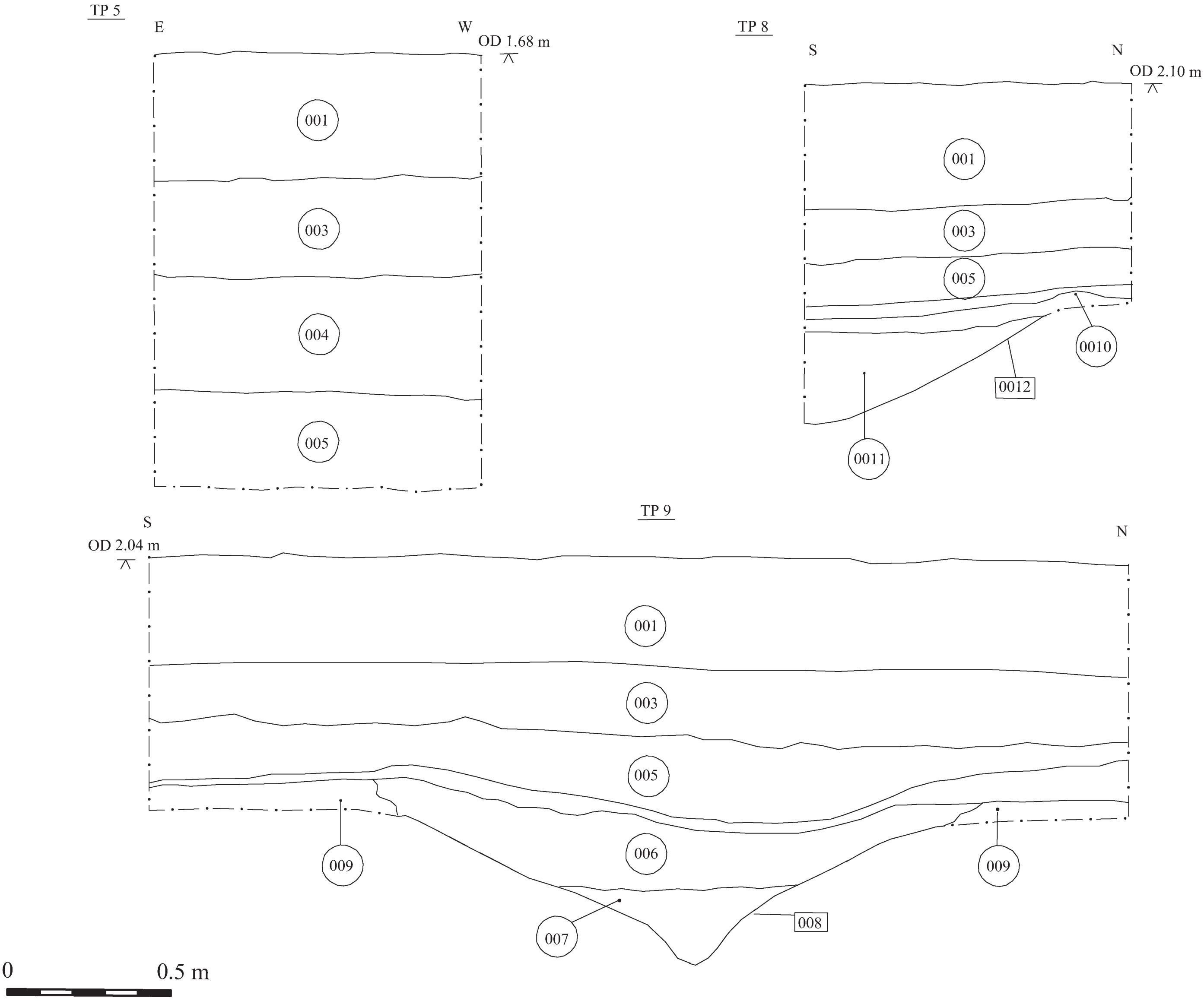


Figure 3.9. Green Wheel test pit profiles TP5, 8 and 9

Northey excavations (1999)

Four trenches were positioned in areas thought to have high archaeological potential. Excavation of trenches NT1–4 was carried out by Soke Archaeological Services Ltd early in the summer of 1999, under the guidance of Peterborough City Council Archaeology Service (PCCAS). Initially a mechanical excavator was used to remove the upper layers of topsoil and alluvium, in spits of no more than 20mm, until the upper buried soil horizons had been reached. An assessment of individual horizons associated with all phases of excavation at Northey is provided below. Routine metal detector sweeps were carried out during both mechanical and hand excavation.

The aims of the project were clear. The test-pit survey had shown that archaeological deposits survived within this area of the Flag Fen basin. In addition to this, it afforded the exciting opportunity of investigating the post alignment's Northey landfall. There were, however, time restrictions. For this reason it was decided to target as many post holes of the alignment as possible in the time allowed. This inevitably meant that some features, although recorded in plan, could not be excavated. Owing to the density of features at the northern end of trench NT2 (*i.e.* the post alignment), a small proportion had to be left unexcavated.

Trench NT1

Trench NT1 (Fig. 3.10) was located along the western edge of the Mustdyke, within the south-eastern corner of Flag Fen, and situated as close as possible to the plotted location of the Northey fen-edge. By this time, the test-pit survey had shown that the survival of *in situ*

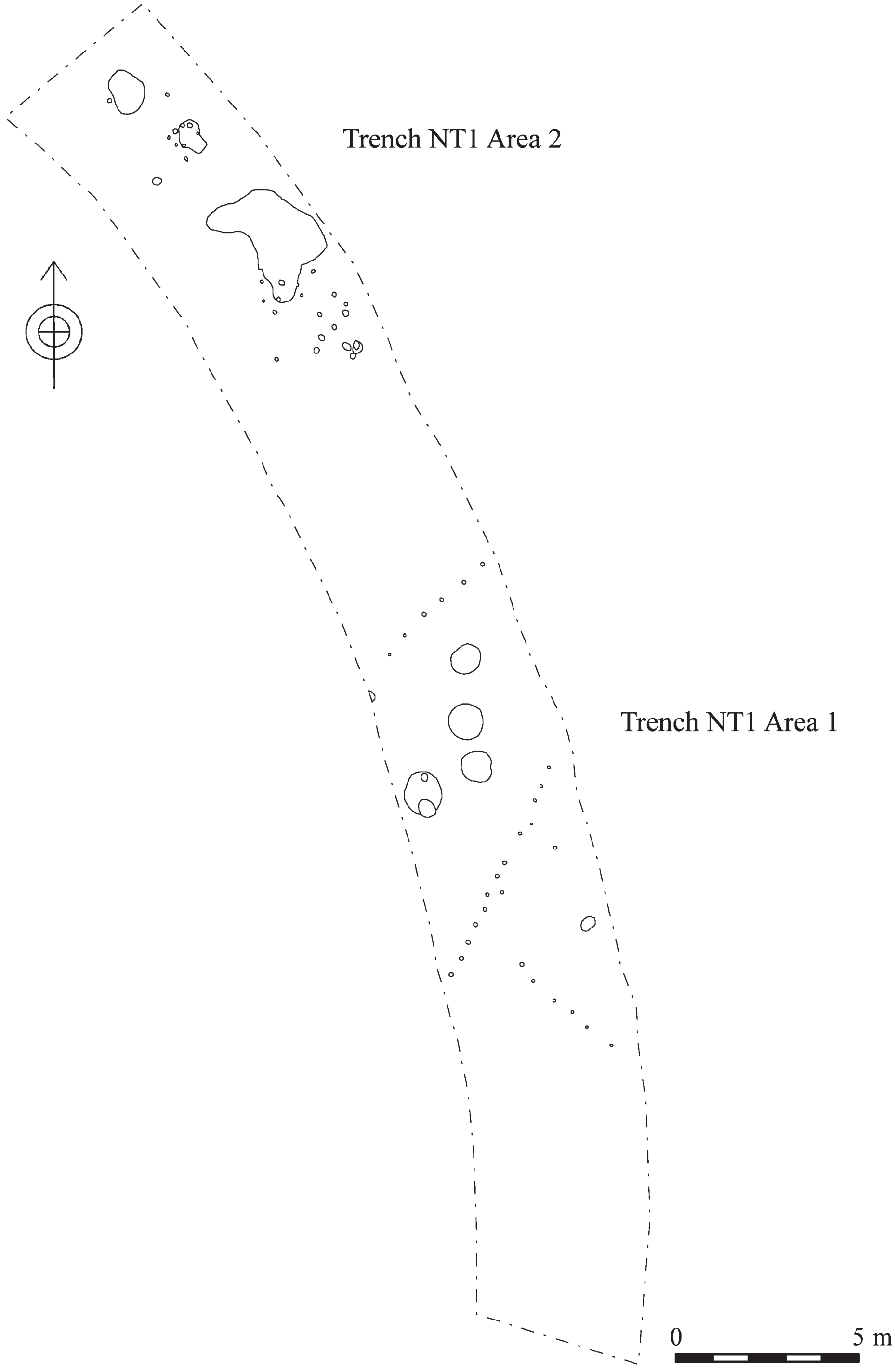


Figure 3.10. Trench NT1

waterlogged deposits might be expected this close to the fen-edge. The trench demonstrated not only that these were present but that they had survived the mechanical cutting and cleaning of the adjacent dyke. Palmer's aerial photographic study suggested that palaeochannels flanked this location on both the eastern and western extents where the higher gravel terrace dropped off into the adjacent fen.

It was clear from the start that significant archaeological deposits were present. The stratigraphic deposit model comprising alluvial peat (003) overlying a buried soil (004) was confirmed, and gave way to a clean, albeit slightly wet, lower gravel terrace. As the upper overburden was removed, clearly defined features started to emerge. From the southern extent of the trench, four large and distinct circular anomalies were present, along with a series of post-holes and stake-holes that could be clearly defined as being associated with former fence lines (Fig. 3.11). Investigation commenced with the excavation of the four similar pits. Each measured approximately 1m in diameter and possessed fills comprising light brown and grey silts.

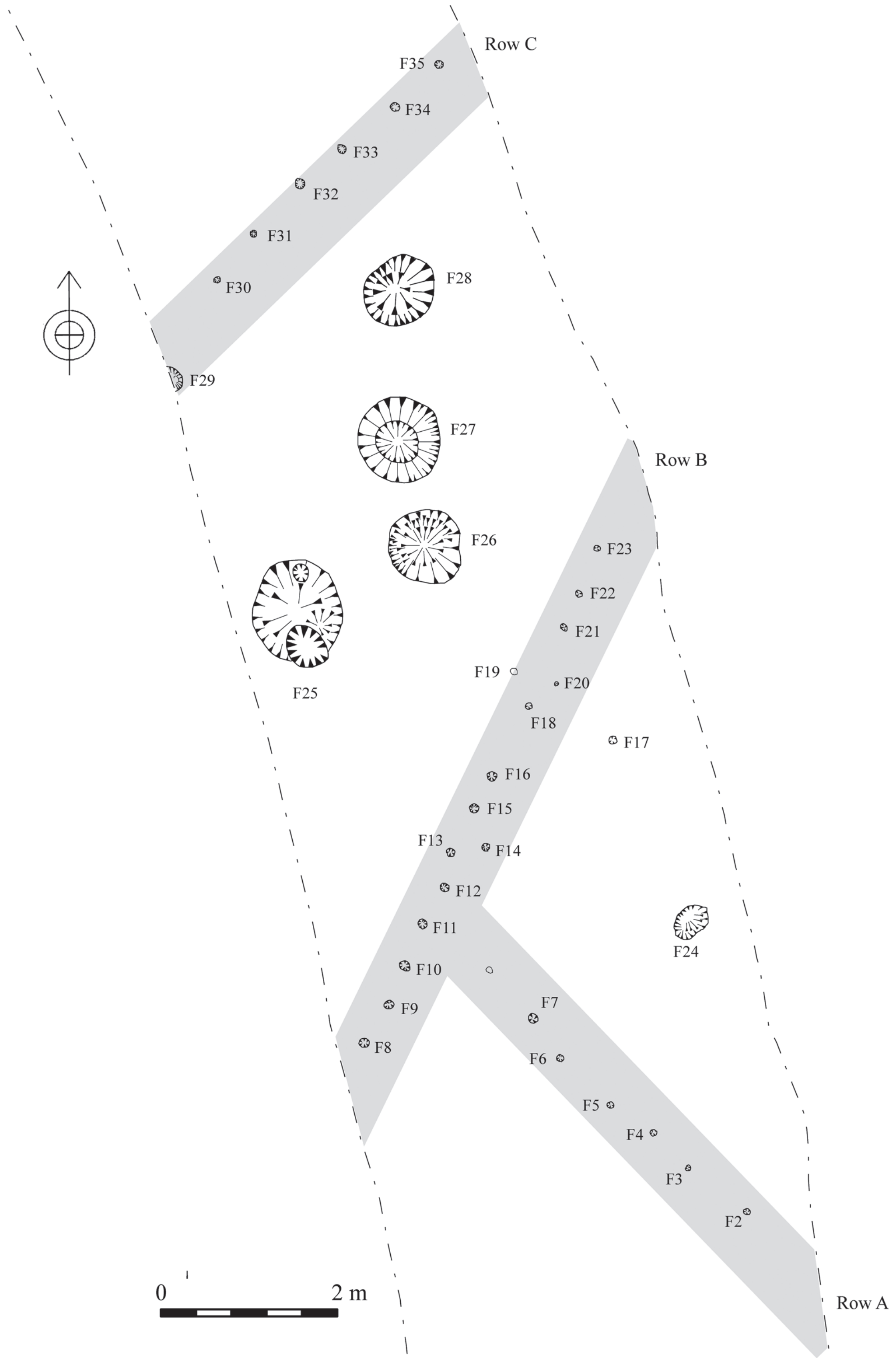


Figure 3.11. Trench NT1, Area 1

Feature F25, however, the largest of the group, consisted of three cuts, each of which represented an individual pit. Lower pit [124] had been truncated on the northern side by pit [065] and on the southern side by pit [067]. Each feature was circular in plan: [065] was 1.35m in diameter and 0.95m in depth, and had gradually sloping sides and an uneven base; [067] was 0.23m in diameter and 0.07m in depth, and had sides which sloped at 45° and a concave base; and [124] was 0.7m in diameter and 0.22m in depth, with sides that sloped at 60°, with the exception of the

western edge, which was near-vertical. Beaker pottery from the filling of these feature suggested an Early Bronze Age date (Pryor, Chapter 8, this volume). Adjacent features F26, F27 and F28 were similar in size to one another, with F26 measuring 1.10–1.15m in diameter and 0.37m in depth, F27 measuring 1.1–1.15m in diameter and 0.49m in depth and F28 measuring 0.98m in diameter and 0.36m in depth. All three features had steep sides and a concave base.

Surrounding the four pits was a series of stake-holes which formed linear patterns strongly indicative of former fence lines. To the immediate south of the pits, within the southern extent of trench NT1, two rows (A and B), labelled as Group 117, were set out tangentially to each other. Seven of these features (F1–F7) were aligned east-west (Row A), and appeared to continue outside the limit of excavation.

The stake-holes varied in depth from 0.02m to 0.15m, and each was roughly circular or oval in plan with vertical sides. The deeper cuts possessed pointed bases, suggesting driven posts. F3 and F6 contained the remnants of the wooden posts. Sixteen further stake-holes that complete Group 117 formed an north-south alignment (Row B); each possessed similar characteristics to those of Row A. Features F8–F13, F15–F16, F18 and F21–F23 appeared to form the predominant element of the row alignment, while stake-holes F14, F17 and F19 were slightly offset. In addition to this, a distinctive gap between F16 and F18 was also recognised, possibly forming an opening. To the north of the Early Bronze Age pits a third row of stake-holes (Row C) formed Group 137 and comprised seven similar features (F29–F35).

The northern extent of trench NT1 differed greatly, with three dominant features present (Fig. 3.12). Directly north of Row C a cluster of larger post-holes formed Group 73: F36 measured 0.15m in diameter and depth and had vertical sides and a pointed base, while F37, the largest of the group, measured 0.2m in diameter and 0.24m in depth. F38, which completed the group, measured 0.2m in diameter and had steep sloping sides and a blunt, pointed base at a depth of 0.11m. Adjacent to this group to the north, a series of eight further post-holes (F39–F46) may form two additional, albeit misaligned, rows orientated north-east–south-west. A large irregular-shaped feature to the north of these post-holes initially caused some confusion. However, after extensive investigations three separate phases of activity were deciphered. It became clear that this large anomaly, initially labelled F56, actually formed two separate, yet distinctive, post-construction pits (F56a [078] and 56b [080]) positioned to either side of (or within) a curvilinear gully, F56c [079]. Initial interpretations suggested that these three features may be contemporary, although it is possible that the gully pre-dated the two post-construction pits. If that is so, the series of nine small post-holes and stake-holes F47–F54 could have formed a regular curving pattern centred on F56a, together possibly forming a feature in themselves.

Three remaining features were present within the northern extent of trench NT1. An isolated post-hole F57 may possible be related to F56 above. A short distance to the east, there was another group of features which was labelled PC1 and consisted of a series of small stake-holes surrounding a shallow flat-based pit. Unfortunately the records of this feature are not available, as they were destroyed by the fire of 2000 (Chapter 4, this volume). The northernmost feature in the trench, F59, was the most dominant and clearly represented a former hearth. This prehistoric feature, coupled with two post-holes (F58 and F60) possibly functioning as roasting-spit supports, was ovoid in plan, measured 0.80m by 1.10m and was 0.20m deep, with shallow sloping sides and a flat base. Two distinctive fills were associated with this feature, of which the latter (013) consisted of light grey/brown silt with moderate inclusions of rounded and sub-angular stone, flint fragments and charcoal. It was noted during the excavations that the interface between this fill and the overlying buried soil was unclear, the fill could therefore be composed predominantly of the buried soil material, by means of natural infilling during the post-depositional process. The primary fill (107) of the hearth consisted of firm and very dark grey/black silt with occasional small rounded stones (granite), as well as rounded and sub-rounded sandstone and flint, all of which were fire-cracked or scorched, within a charcoal/ash deposit.

Trench NT2

Trench NT2 (Fig. 3.13) was located on the opposite bank of the Mustdyke, along the eastern boundary of Flag Fen. As with trench NT1, this trench was positioned to investigate the western Northey fen-edge and assess the impact of the proposed Green Wheel cycleway. In contrast to the area in which trench NT1 was opened, the preliminary survey had covered this area in some detail, with seven test pits (TP1–3 and TP8–11) being dug along the alignment of the trench. Of particular interest was the dense distribution of stake-holes, post-holes, pits and a possible ditch located at the northern extent of trench NT2. For this reason, it was decided that a wider excavation area was required in order to fully assess the extent of previously located features that had been attributed to the Flag Fen post alignment itself, and the northern end of the 5m-wide trench was thus enlarged to 13×11m.

Most archaeological features were found in the northern and southern parts of the trench. The southern part revealed a series of features that were probably a continuation of those on the opposite side of the Mustdyke in trench NT1; prominent among these was a somewhat smaller post-hole with Beaker pottery (Fig. 3.14). This feature (F68) was irregular in plan and profile and contained a single fill (432) which comprised light grey sandy silt and included lattice-decorated fragments of Beaker pottery and a small flint blade. This material may have been part of a deliberate, perhaps ritual, 'placed' deposit. It is also possible that F68 could have been part of a larger structure, as there is a distinct alignment of features (F69, F71, F75 and F77) oriented south-east–north-west to the north-west of F68, along with a cluster of features (F61–F66) to the

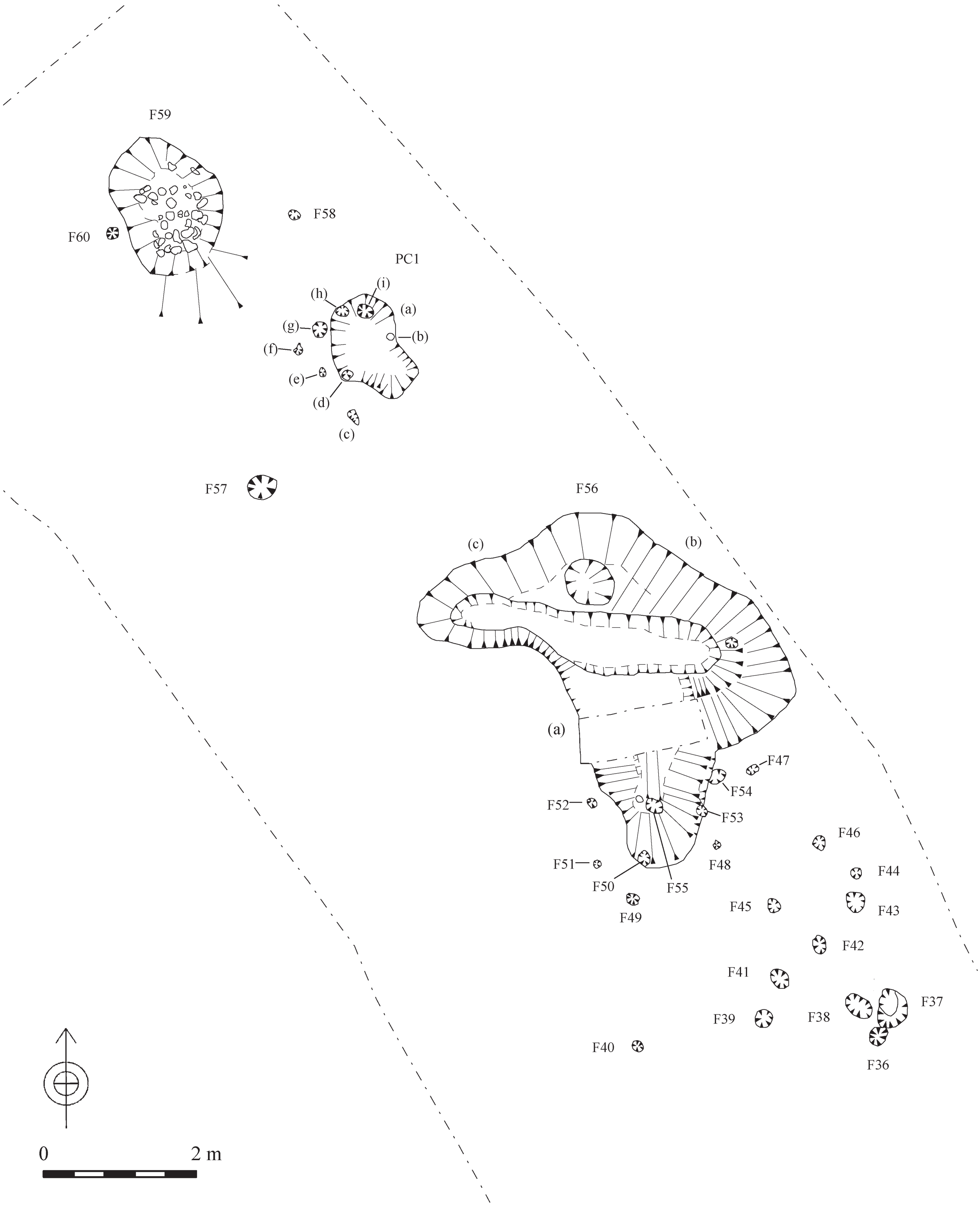


Figure 3.12. Trench NT1, Area 2

south-east of and adjacent to F68. To the north, similar patterns and alignments can be traced between associated post-holes. Two parallel rows can also be traced on a north-east–south-west alignment incorporating features F83–F85, F87–F88, F94–F95 along with features F89, F92–F93 and F96 (Fig. 3.15). Taken together, these two parallel rows form an approximate right-angle with the south-east–north-west alignment to the south, possibly forming a junction at F89. F89 is of interest in itself, as it appears to be formed of many stake-holes and possibly represents the renewal or support of weakening structural timbers.

The northern extent of trench NT2 was dominated by a ditch orientated east–west (D1), which was initially thought to be curving or horseshoe-shaped, possibly forming a 'henge'-type monument (Fig. 3.16). This feature was first identified in Test Pit 9 of the preliminary investigations, and a clear butt-end was found in the northern extent of trench NT2 (actually within the area of the post alignment itself). Our initial suggestion was that it represented a precursor of the post alignment; subsequently, however, it became clear that the curvature was an illusion caused by later deposits, and that the ditch was actually relatively straight. It had gently sloping sides and a rounded bottom that had been naturally filled by silting (007) (381) during wet periods; much later these layers of infill were capped by redeposited gravel (270) probably washed in from the Fen Causeway, a short distance to the north (see trench NT3, Fig. 3.20). What is interesting about this feature is that it quite evidently pre-dated the Flag Fen post alignment: at least a dozen post-holes and stake-holes cut through its upper layers of filling, and F266 and F267 clearly penetrate all but the earliest phase of ditch infill.

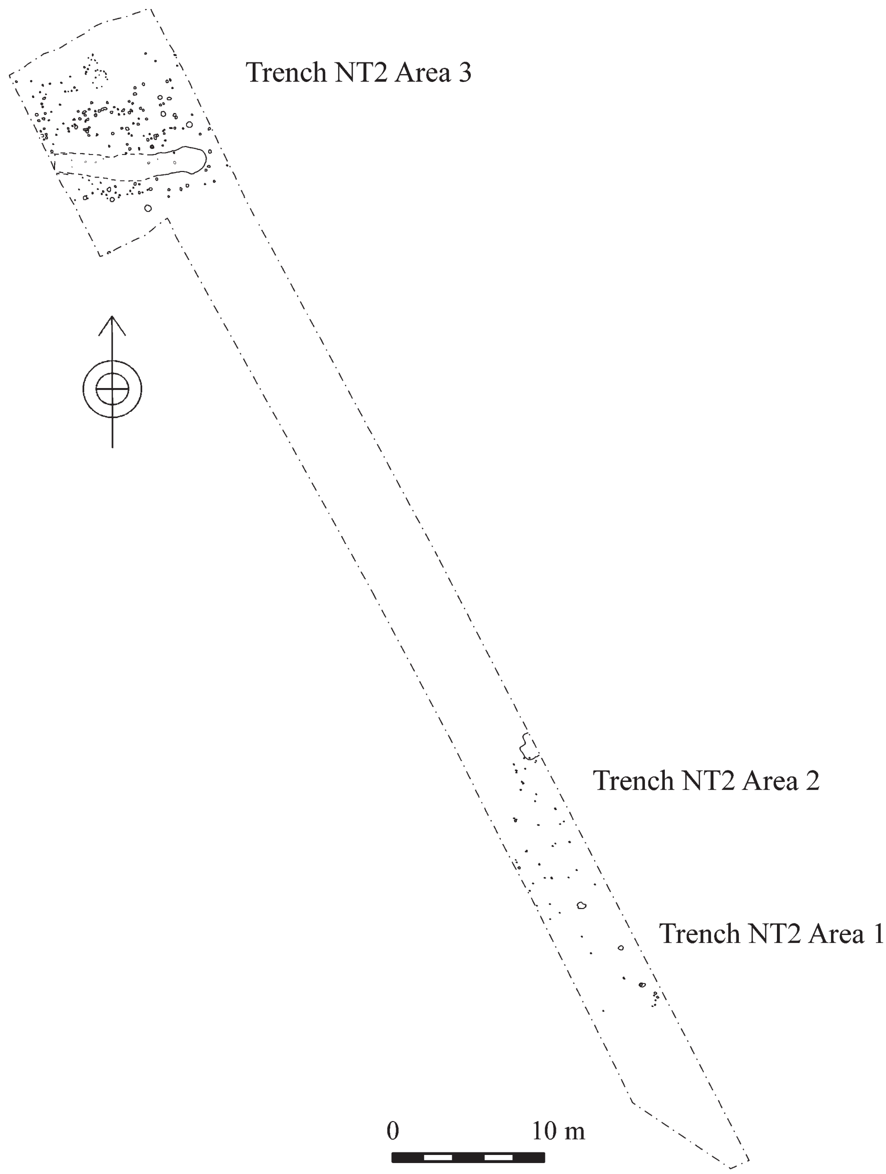


Figure 3.13. Trench NT2

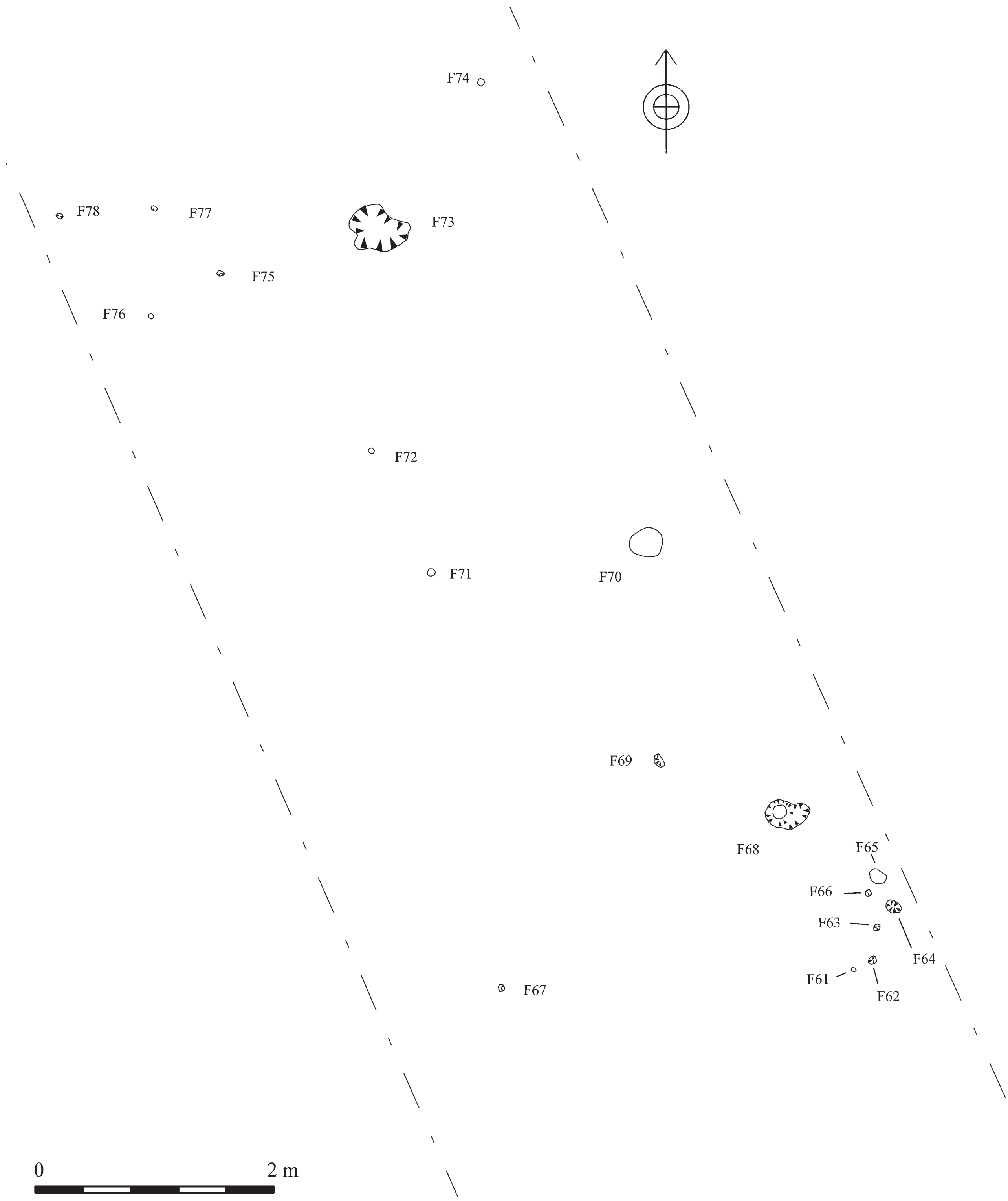


Figure 3.14. Trench NT2, Area 1

Figure 3.15. Trench NT2, Area 2

The remainder of the northern extent of trench NT2 was notable for the high frequency of post-holes and stake-holes, which varied in size and shape; in addition, some had the rotted tips of former posts remaining *in situ*. The arrangement of posts, stake- and post-holes respects the alignment of the ditch, which was east–west, at right-angles to the fen-edge. This indicates that the timber monument may have followed the alignment of earlier features. Immediately south of ditch D1 a straight east–west alignment of post- and stake-holes is apparent. From west to east, this row includes F134 to F118, and probably also includes a number of other features on either side, forming

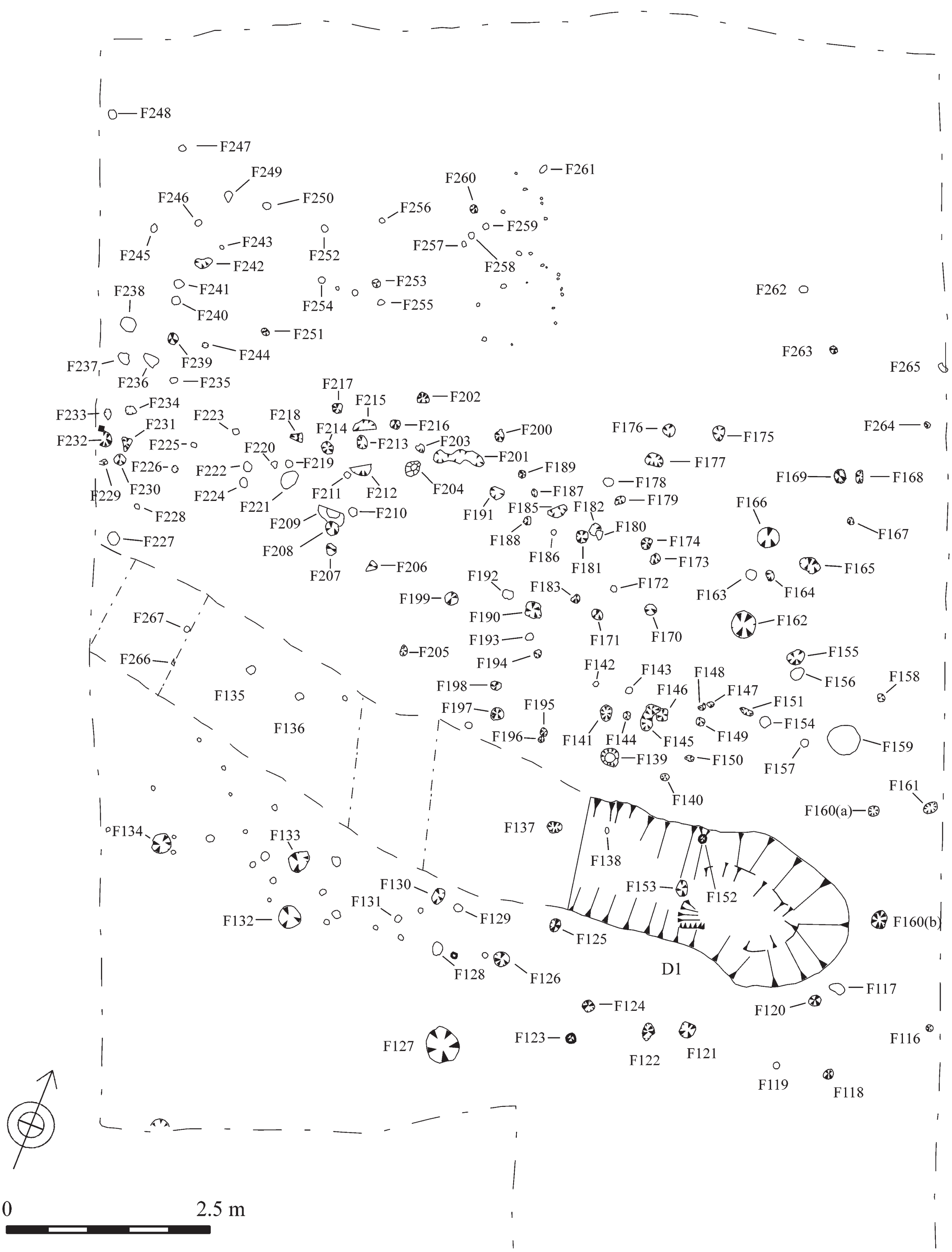


Figure 3.16. Trench NT2, Area 3

a band or corridor approximately 1.5–2m wide. Other rows can also be seen in the northern area of trench NT2 in the form of five equally spaced parallel lines (Fig. 3.18; Fig. 3.19). It seems probable that these rows correspond with the five rows observed earlier in, for example, Area 6 (Pryor 2001, Fig. 6.40).

Trench NT3

Trench NT3 (Fig. 3.17) was located approximately 10m north of trench NT2, along the eastern boundary of Flag Fen. As with previous investigations to the south, this trench was positioned to investigate the western Northey fen-edge and the Fen Causeway Roman road.

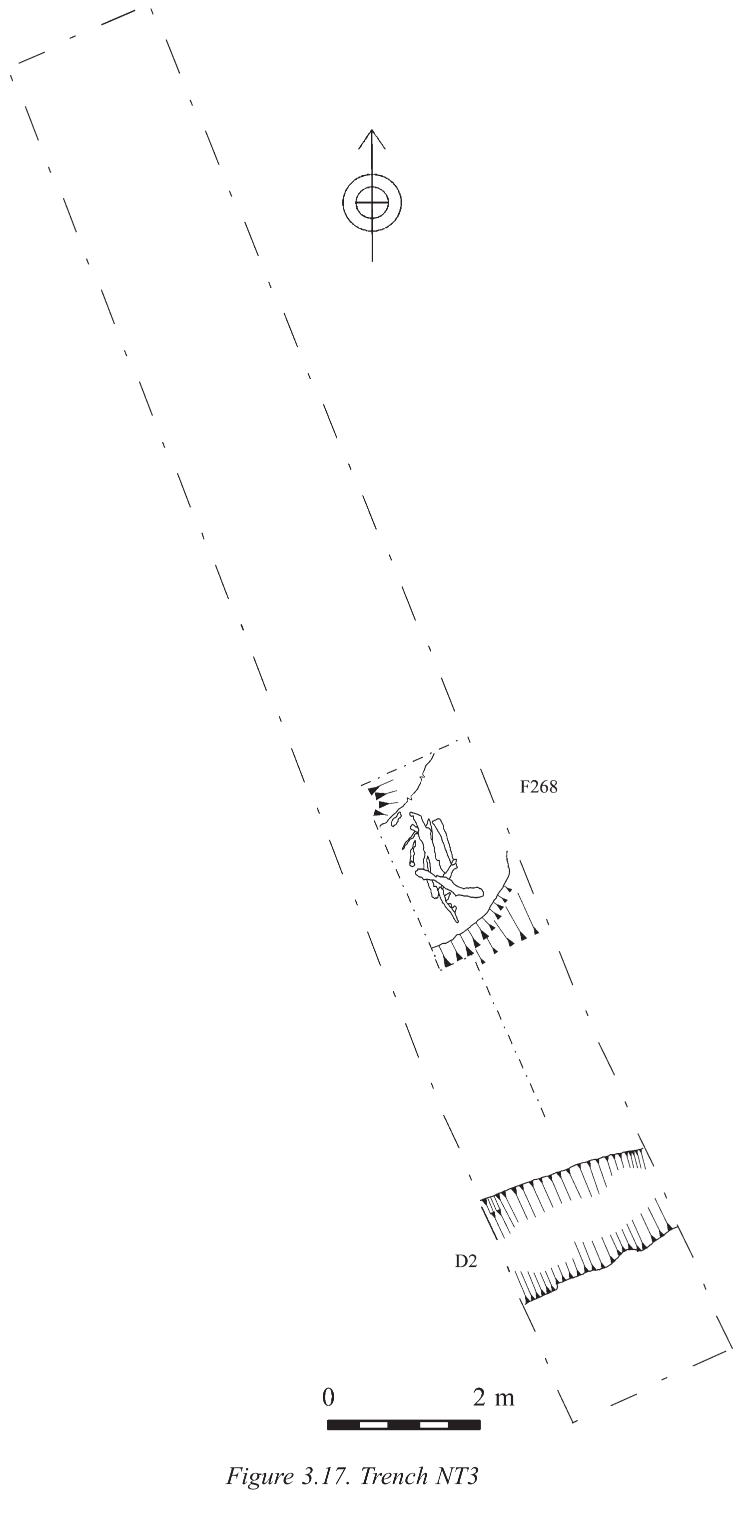


Figure 3.17. Trench NT3

The archaeological deposit model of the preliminary test-pit survey was used to evaluate the various deposits and their preservation. The Fen Causeway (F409) was the most prominent archaeological feature. Figure 3.20 illustrates the complete eastern-facing common stratigraphic deposit model recorded within trench NT3, with additional feature numbers being assigned during the analysis where appropriate. The topsoil horizon (227) remained intact across the trench, albeit truncated by five later post-pits of a recent field boundary. The Fen Causeway (F409) was clearly visible beneath the topsoil. The sand and gravel make-up of the roadway, which was 0.32m deep and had a surviving horizontal extent of 4.3m, had been truncated, probably quite recently. One side ditch (F410) of the road was clearly visible, together with washed-off gravel (230) and redeposited ditch filling (229). The Roman road sealed an underlying desiccated peat horizon (280) which in turn sealed prehistoric deposits.

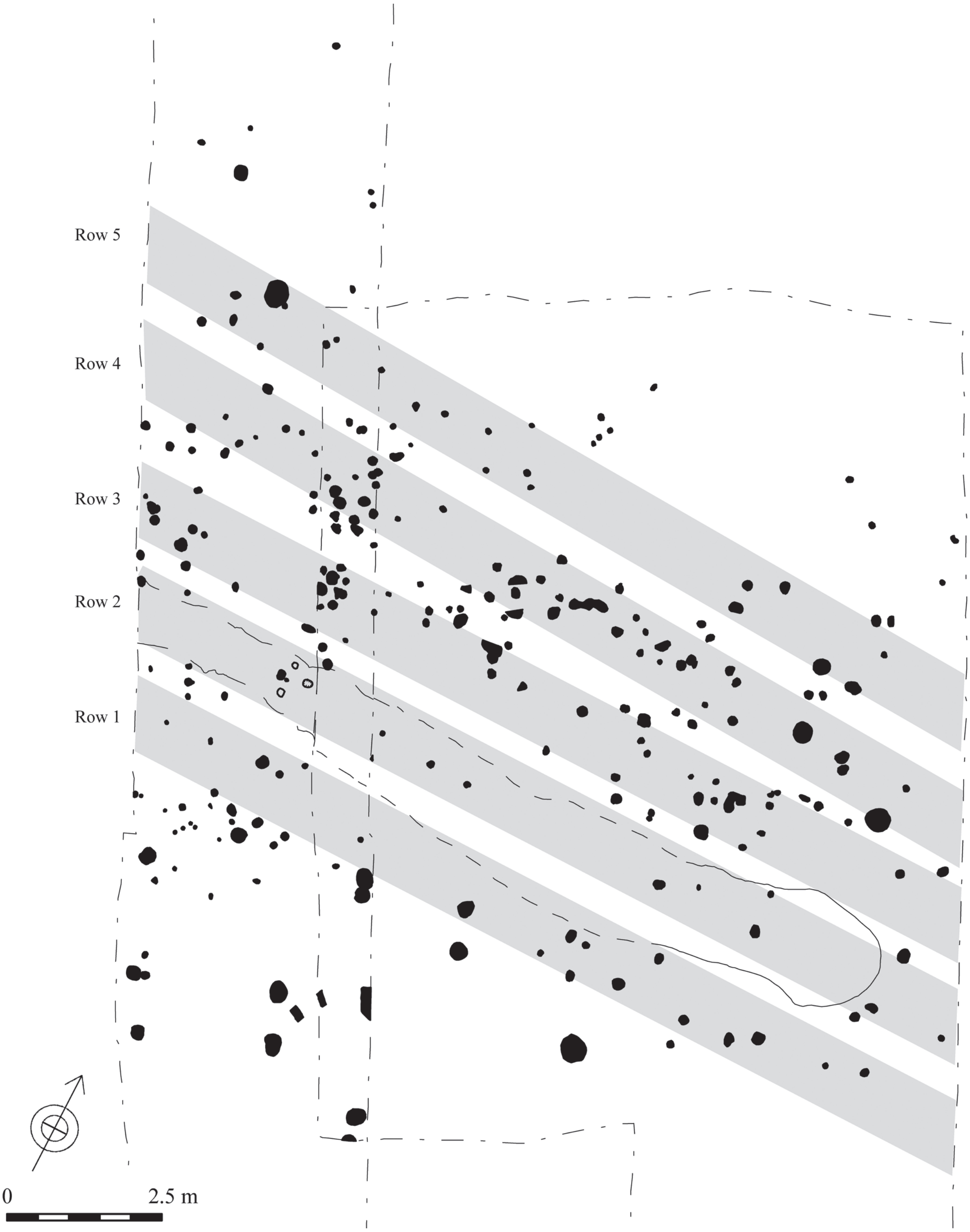


Figure 3.18. Interpretative plan of post alignment in Trenches NT2 and 2003/2

In plan, two other features were also prominent in this trench. At the southern end F268 appeared to terminate at its eastern extent, and curve towards the south at its western extent, before disappearing into the baulk (Fig. 3.17). Initially, eleven individual contexts (226, 337, 513, 346, 507, 318, 507, 505, 370, 504 and 509) were recorded within this feature, all of which are associated with a possible well-type structure. Reassessment of the feature, however, suggested that at least a second phase of additional activity may be represented by the filling (507), which appears to be truncated by the silty clay of (504). It is also possible that fill (378) could have formed the primary silting of a third recut. If this feature was a well or watering hole, then regular maintenance recutting down to the water table would

Row 1		F134	F133	F132	F131	F128	F126	F124	F122	F121	F119	F118
Row 2		F267	F266	F135	F136	F137	F138		F153			F160
Row 3	F232	F226	F207	F206	F199	F193	F194	F143	F146	F149	F160A	F161
Row 4	F238	F215	F213	F204	F191	F188	F186	F181	F162	F155	F158	
Row 5	F242	F243					F177	F165	F166			

Figure 3.19. Feature numbers assigned to post rows on the Northey landfall (see also Figs 3.16 and 3.32)

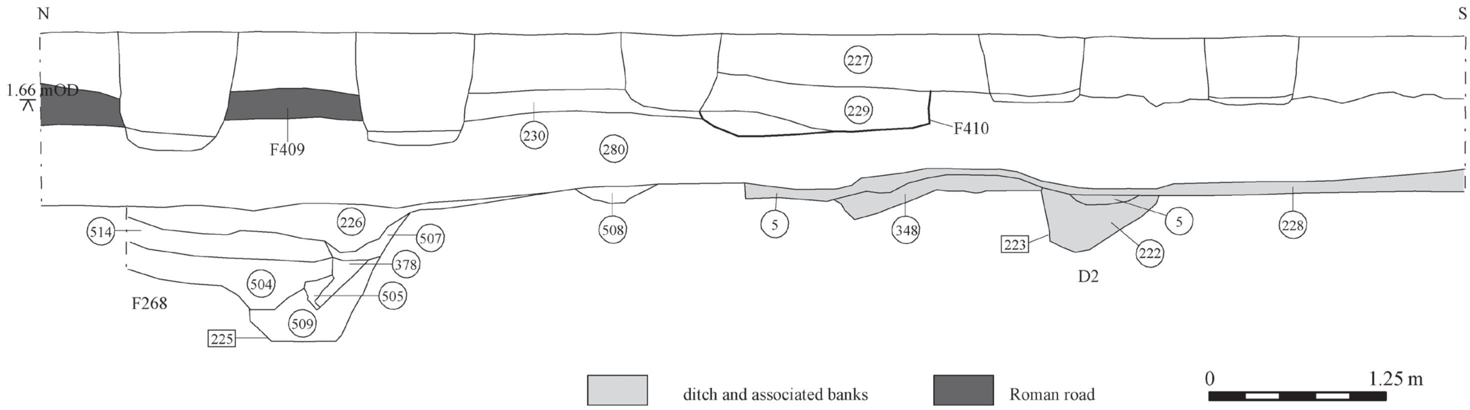


Figure 3.20. Section of trench NT3

have been required. A dried timber lying at the bottom of the feature might once have formed part of a lining, although it is also possible that it was merely discarded rubbish.

The second important feature in this trench was a linear ditch (D2) [233] and its associated banks (348 and 228), which were oriented east–west across the southern end of the trench. This probably formed part of a prehistoric field system, and would have drained downslope into the fen basin to the west. The primary fill of the ditch (222) comprised firm pale grey clayey silt with occasional charcoal flecks. This deposit produced only one small weathered sherd of pottery, possibly of later Neolithic to Middle Bronze Age date (F. Pryor pers. comm.).

Trench NT4

Trench NT4 (Fig. 3.21) was located between the eastern extent of the Flag Fen border and the Northey Road, and was positioned along the line of the new Flag Fen access road. There were no initial test pits to provide a deposit model, but the air photographs were quite clear. The trench was therefore positioned to expose a rectangular enclosure and parts of surrounding field systems.

Two ditches (D3 and D4) were revealed, along with six pits and two post-holes, all primarily located within the central and eastern areas of the trench. The two ditches had similar profiles and and infilling, which consisted of a tertiary and desiccated peaty layer (542); this followed earlier phases of silting and encroachment. The fills of the ditch suggest an initial phase in which gravel slumped in from the sides (554). It seems probable that these two ditches formed part of the rectilinear enclosure identified on the aerial photographic survey and are therefore likely to be contemporary with an associated circular feature (not on the line of the new access road). A further ditch (D5) within the enclosure was recorded in plan, but not excavated.

Two potential pyre deposits or cremations (F272 and F274) were found by two post-holes, F273 and F275, and a possible gully, F277. Two other features (F271 and 276) east of the enclosure were not excavated, although two fragments of Late Bronze Age pottery were retrieved from the surface filling of F271. It is probable that these sherds are residual; this area was also disturbed by the cutting of a 19th-century drainage ditch (D6) to the west. Two flint blades were retrieved from closed contexts associated with pit F269, suggesting a possible Neolithic date.

Recent excavations at Northey: 3. *Time Team* (1999)

Introduction

Flag Fen formed the subject of an episode of Channel 4's *Time Team* (Series 7) and it was decided to use this opportunity to investigate the state of the post alignment's preservation close to the Northey landfall and to examine the date and preservation of a round barrow on the higher ground of Northey 'island' close to Northey Road.

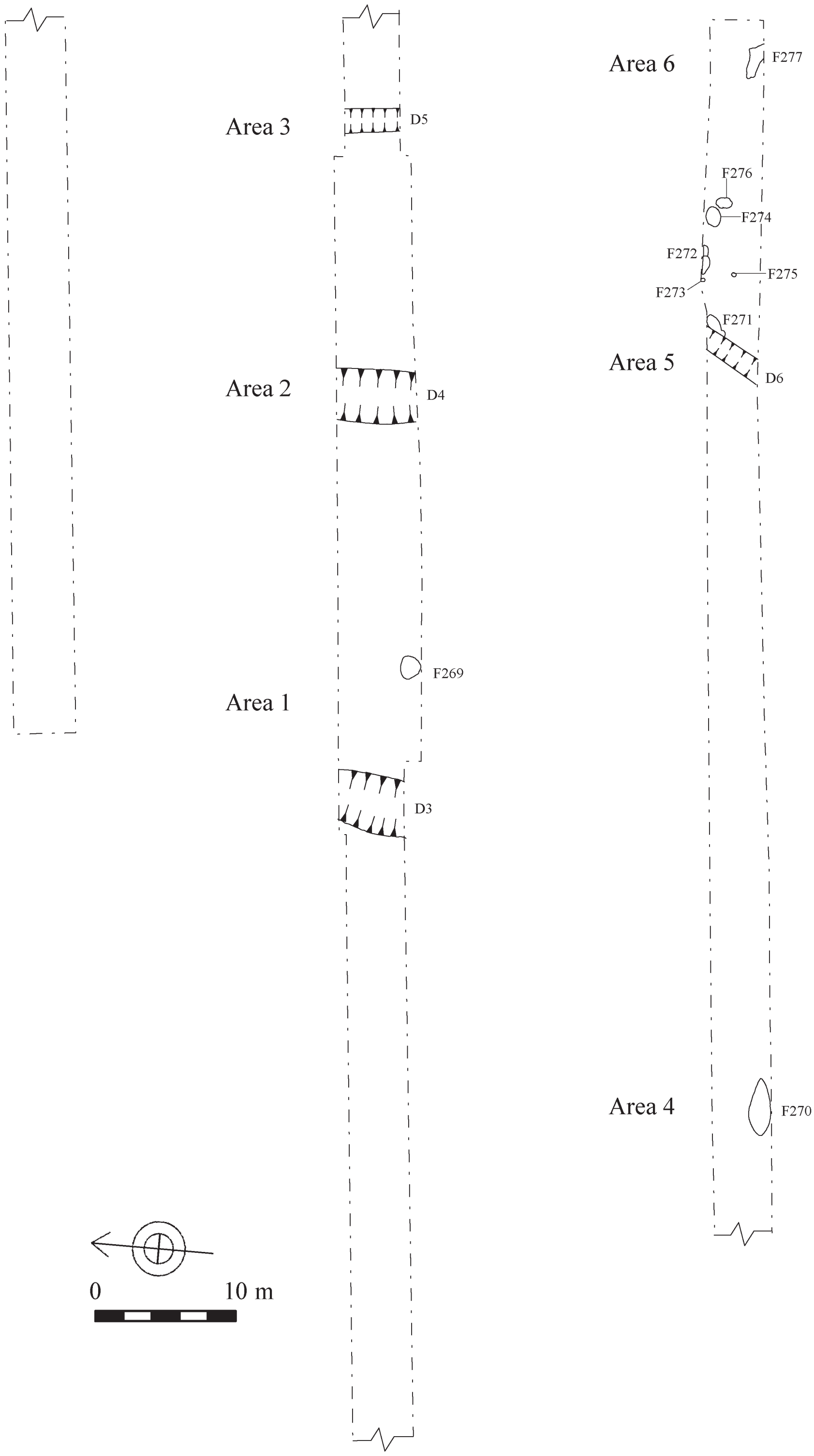


Figure 3.21. Trench NT4

The excavations

The three days of the *Time Team* excavations were 18–20 May 1999, with an additional day of recording, sampling and back-filling on 21 May. Work had just been completed on the Green Wheel trenches (NT1–1, VC1 and TP1–12) discussed above. Excavation was carried out by *Time Team* archaeologists and by the existing team employed by Flag Fen to investigate the new access road and the Green Wheel cycleway (NT4). Initially as many as six or seven trenches were proposed, focusing on both the lower wetland deposits within the eastern extent of the Flag Fen monument and the upper dryland deposits associated with recent excavations on the Northey landfall. It was soon realised that three days is not nearly enough time to fully excavate an evaluation trench in waterlogged deposits, so it was decided that a series of shallow assessment trenches would be laid out to confirm the location of the post alignment between the Preservation Hall and the Northey landfall, represented by the line of the Green Wheel cycleway (TT1–7) (Fig. 3.6).

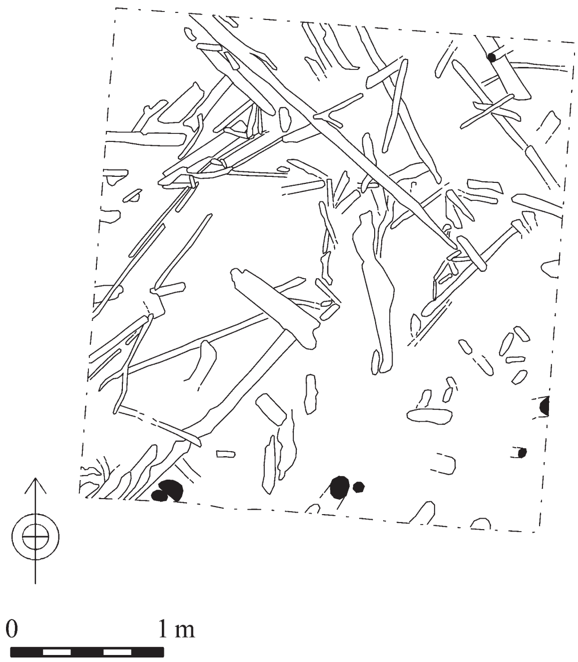


Figure 3.22. Trench TT1

Trench TT1

Trench TT1 (Fig. 3.22) was positioned to the east of the Preservation Hall. Initially 0.36m of topsoil was removed down to a rich brown peat deposit, within which large quantities of horizontal timbers were uncovered, some of them reaching a length of at least 5m and a thickness of 0.24m. Seven upright timbers were seen, two of which, in the south-west corner, were half-split. The southern uprights appeared to be on the correct line to be considered as part of the post alignment, although none of the timbers exposed appeared to have been worked. This is probably due to the poorer preservation conditions at this higher, more desiccated level. The loose timbers from this initial spit were removed, allocated context numbers, and placed in water-filled tanks.

The second spit showed much the same: seemingly randomly distributed horizontal timbers and wood (1101), along with one upright, in the south of the trench, and three half timbers and one small upright in the north-east corner of the trench. Time constraints meant that no more spits were excavated in this area, so the structural nature of the post alignment could not be investigated further.

Trench TT2

The aerial photographic survey showed extensive multi-phased enclosures, field systems, droveways and ring-ditches on the higher land around the new access road and Northey Road (Fig. 3.2). Some of these features had already been examined by this time, confirming the presence of a rectilinear ditched enclosure within Trench NT4. *Time Team* were offered the opportunity to investigate a potential round barrow site located immediately to the east of the Northey Road, approximately 1km away from the platform at Flag Fen, which had been identified from the aerial photographic analysis. Northey Road had, in fact, truncated the western third of this circular feature.

Trench TT2 (Fig. 3.23), which was 20m long, 1.5m wide and north-west–south-east, was excavated *c.*10–20m to the east of Northey Road, and cut through the centre of the plotted location of the potential barrow ring-ditch. It was immediately apparent that the site had suffered considerably from plough damage (the barrow itself was barely visible on the surface) and the acidic nature of underlying silts and gravels meant that very little survived. Initially, excavation ceased at a depth of approximately 0.39m, at which point a homogenous mixture of silts and gravels had been reached (1220). Hand cleaning began immediately in an attempt to find a ditch and/or bank, together with any discrete features such as secondary cremations that might indicate a barrow, but nothing was found.

Next it was decided that the upper surface should be carefully removed by machine. This strategy proved successful. After the excavation of an additional 0.1m of overburden, clean orange gravel was reached and archaeological features, including at least one ditch (in the predicted location), were evident. The upper, blanketing, horizon (1220) had probably been formed by a mixture of buried silty soils with a plough headland and perhaps upcast from the nearby road.

Excavation of the ring-ditch (D8) commenced immediately. It was found towards the eastern end of the trench, where it was aligned north–south. The ditch included a number of deposits (1212–1220), which suggests that it filled up through natural weathering over time, a process that doubtless included the erosion of barrow mound material. In the north-facing section, a concave mid-yellow-brown

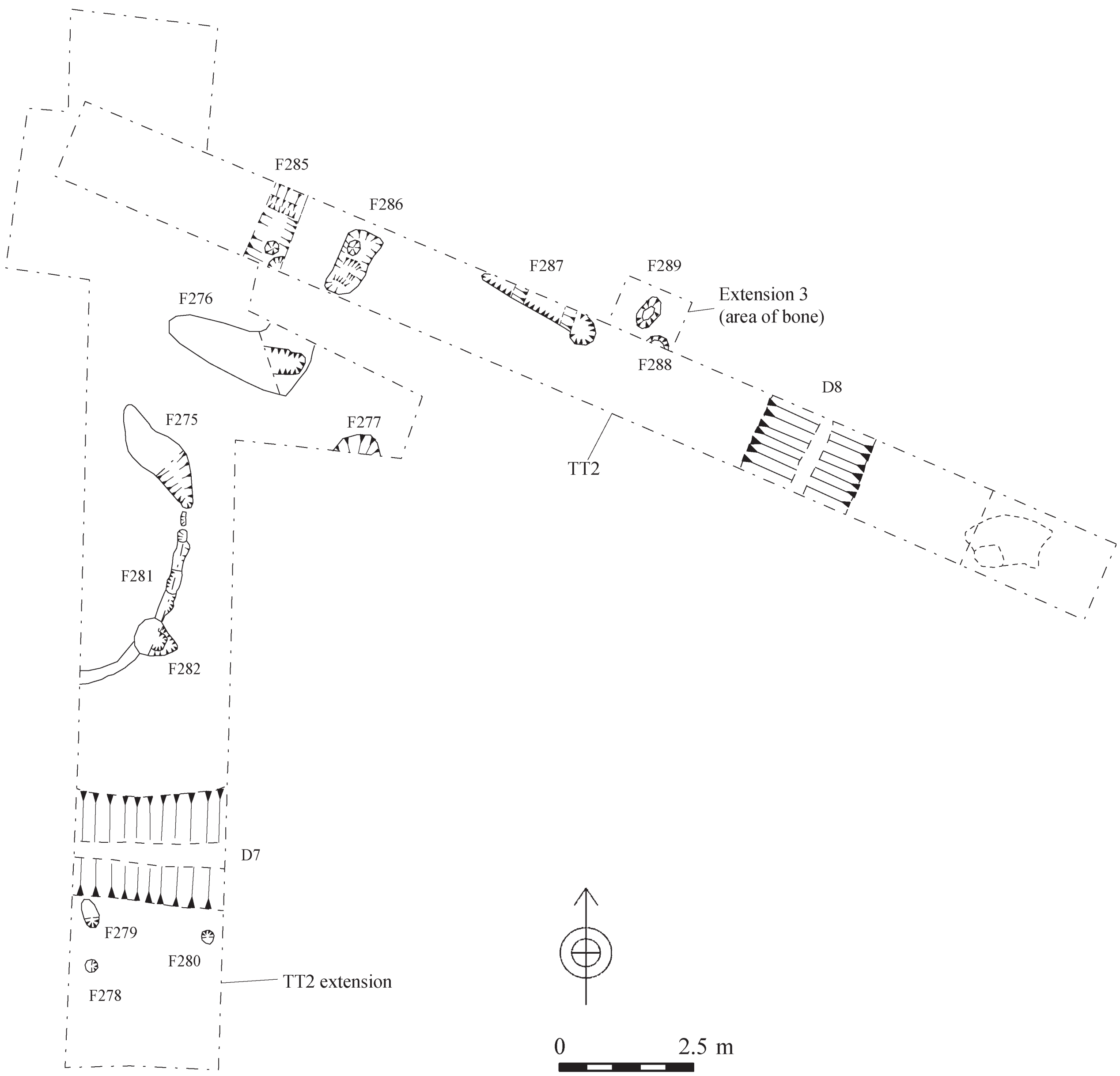


Figure 3.23. Trench TT2

gravelly deposit (1240) was found immediately beyond the western brink of the ditch. This appeared to be an associated internal bank, but it required further investigation.

It was therefore decided that the trench be extended, and a new length of trench was opened from the western end of the initial investigation; this was aligned north–south and was 20m long and 2.8m wide. A circular anomaly located during a geophysical assessment indicated the presence of an additional archaeological feature in this area, and it was hoped that the excavation would determine whether or not the feature was another barrow, as the shape suggested. This was to prove the case. The new ditch (D7) was similar to D8, and also had an accompanying bank.

An additional feature was found in the extension to Trench TT2. F281, which was situated north of ditch D7, was initially thought to represent the remains of a foundation slot or drip gully. It curved from the west towards the centre of the trench, and then turned to run north–south. It terminated to the north with a narrow rounded end. There did not appear to be any continuation of the feature further north, but its course may have obscured by a possible tree-throw pit, F275. If F281 was indeed a drip gully, possibly associated with a round building, it must pre-date the barrow.

On the third and final day of the excavation the first slight evidence for funerary activity was recovered. Phosphate survey of the buried soil had recorded a high concentration directly west of D8, within the circular enclosure. This may,

of course, have been the result of animal husbandry, but it could equally well indicate the former presence of bone or organic remains. A further extension 9.10m from the eastern end of the original trench was laid out to investigate the area of high phosphate. It measured 1.0×1.2m and was placed along the northern side of the trench. Once the ploughsoil had been removed two irregular spreads of highly comminuted calcined bone and fractured dental enamel were exposed (1241 and 1242). Unfortunately none of this material proved diagnostic.

Trench TT3

Trench TT3 was a small sondage opened on the line of the post alignment that had already been exposed some 50m to the WNW in Trench TT1. The trench was excavated to determine whether the edge of the Pleistocene gravel 'island', seen in Trench NT2 and on aerial photographs, extended this far west.

Topsoil was removed mechanically down to (1301), a mid-grey-brown alluvium 0.24m thick with dark orange mottling and limestone, gravel and sandy inclusions. This was probably the blanketing late Roman and early medieval alluvial deposit seen elsewhere at Flag Fen (Pryor 1992). This alluvium covered a thin layer of sand and fine gravel (1302), which was probably deposited during a brief flooding event, and in turn overlay a dark grey desiccated peat deposit (1304). Beneath this peat was a mid-grey silt which formed a buried soil, mixed with some sand and gravel. This in turn lay above the undisturbed Pleistocene gravels (1305). A vertical oak post had been driven into (1305) on the south side of the trench; it survived to a height of 0.68m and was 0.20m wide. This was possibly part of the same timber structure indicated by the two posts found in Trench TT4, to the west.

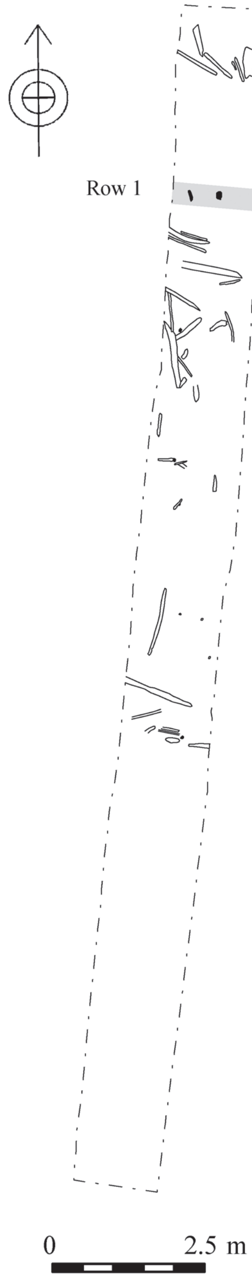


Figure 3.24. Trench TT4

Trench TT4

This trench was opened to examine a length of the post alignment towards its eastern limit. Given the constraints of time and labour it was decided that the southern, rather than the northern, side should be excavated, as most of the metalwork found in previous years at the Fengate landfall had been found on that side. The trench was aligned north–south and measured 17×1.5m (Fig. 3.24).

The northern area of the trench was excavated to a depth of 0.92m and the southern to 1.24m, down to a buff-coloured fine sandy silt natural subsoil (1404). Above this lay the peat deposit seen in Trench TT3 (1304) and in previous excavations (Pryor 1992). A peaty layer (1402) which included cut lengths of roundwood within and on top of the peat, presumably incorporated while it was forming, was above this. The majority of the larger pieces were oriented ESE–WNW and were up to 2.50m long and 0.50m wide. Most of this wood was at the northern end of the trench. Other smaller, apparently randomly distributed, wood was also noted; this did not appear to be structural, and had probably washed or floated there naturally. Apart from the placed horizontal wood, two vertical roundwood oak timbers were found in the north of the trench, on the same approximate alignment as the southernmost post alignment (Row 1).

Other finds of interest included a large number of oval, or egg-shaped, cream and white pebbles scattered throughout the trench. Considering their size and weight, these are unlikely to have been deposited naturally. They might have been deliberate offerings, but more probably found their way into the water with gravel that had been dumped there to consolidate the ground.

Trench TT5

This trench, which measured 7.5m×2.5m, was placed in the north-central part of the field over a small circular anomaly detected by the geophysical survey. Approximately 0.30m of ploughsoil was removed to reveal a thin lens of mid-brown desiccated peat with dark orange oxidation mottling (1501). The peat lay above the buried soil (1502) seen elsewhere both at Fengate and on Northey 'island', which in turn overlay the natural gravel subsoil (1503). The only features seen cutting into the natural subsoil were two very slight parallel linear features 1.5m apart and oriented south-west–north-east. These are likely to be modern pan-busting ploughmarks, a type of deep ploughing designed to break up the ground.

Trench TT6

Trench TT6 was positioned above another circular anomaly detected during the geophysical survey, to the west of Trench TT7. This trench was relatively small (3.5×1.5m), and revealed deposits similar to those of Trench TT5: a dried-out peat layer above a buried soil (1603), which overlay the natural gravel subsoil. No sign of the circular anomaly was seen.

Trench TT7

This trench was positioned approximately 10m east of Trench NT2. The trench was positioned in order to, among other objectives, see whether there were shallow ditches beneath the posts, perhaps evidence of earlier droveways similar to those excavated on the Power Station site at Fengate. Geophysics (caesium vapour techniques) did not reveal posts or post-holes, so the trench was placed on the projected line of the post alignment. Excavation of this trench failed to reveal any posts or post-holes, so it must be concluded that the alignment terminated somewhere between Trenches TT7 and NT2, in which its most easterly features were exposed.

Recent excavations at Northey: 4. Flag Fen New Visitor Centre excavations

Introduction

This section will consider the archaeological monitoring and excavation carried out prior to the development of the New Visitor Centre. The building was positioned as close as possible to the edge of the fen in an area where the preservation of waterlogged archaeological deposits was known to be inferior to other, deeper, parts of Flag Fen. The foundation design involved piles and reinforced concrete ring beams, which were required because of the poor load-bearing characteristics of the alluvial clay subsoil. Although pile foundations can cause little damage, the density of piles required meant that their archaeological impact would have been serious. Accordingly, an excavation was decided upon. The building was also to be surrounded by a shallow moat, which had to be excavated under archaeological conditions.

The archaeological investigation took place in four stages. Stage 1 (evaluation) was an auger survey; this was followed by the excavation of three test pits (Stage 2). Stage 3 was an open-area excavation which extended across half of the proposed moat (Fig. 3.6). The final stage (4) was a watching brief along the service trenches extending between the Old and New Visitor Centres. The evaluation phase of the project took place in the summer of 1999; once the results of this had been considered, excavation of the area threatened by the moat started in January 2000. The subsequent intensive watching brief was carried out intermittently between March 2000 and May 2001. From an archaeological perspective the timing of each phase could not have been better, with warm, bright weather for the auger and test-pit surveys and damper, cooler winter conditions for the excavation of a wetland site. The winter of 1999/2000 was a wet one, resulting in a higher than normal water table, which made the excavation of sometimes quite severely desiccated wood very much more straightforward.

Stage 1: auger survey

The auger survey was conducted at the end of August 1999, and consisted of sixteen boreholes taken with a hand auger and set out so as to target the areas of maximum impact from the future development. Boreholes penetrated to a depth of approximately 3m, and although little wood was encountered, the depth and sequence of fen deposits were recorded.

Stage 2: test-pit survey

On 7 September 1999 three test pits were arranged across a known palaeochannel to evaluate the preservation of archaeological remains and to confirm the sedimentology observed in the auger survey. Removal of the topsoil (001) exposed a common stratigraphic sequence comprising upper levels of desiccated alluvium (002) and peat (003) and a horizon of wetter peat (004) at a depth of 1m (-0.3m to -0.5m OD). The remaining fen deposits were removed by hand, using shovels and trowels, down to the glacial clay, at a level of -1.3m to -1.5m OD.

Although the landscapes of Northey and Fengate are rich in archaeological remains, and the New Visitor Centre is near to both the post alignment and the platform, preliminary investigations suggested that the area would yield little archaeological material. This proved generally to be the case. However, during excavation of Test Pit 3 (TP3) a wooden stake was found in isolation within deposits, directly underlying terrace gravels, possibly contemporary with Bronze Age levels. This provided sufficient evidence for further investigations, and the decision was made for an area excavation to cover approximately half of the proposed footprint of the Visitor Centre moat.

Stage 3: excavation

The primary aim of the excavation was to determine the location, extent, date, character, condition, significance and quality of any archaeological material threatened by the proposed development. In addition to this it was also important to establish whether the stake found during the test-pit survey was in isolation or formed part of a group. At the same time it was hoped to determine whether prehistoric activity extended further out into the fen.

The architects' design for the moat required a depth of at least 850mm, so a sub-semi-circular trench was excavated to a level of approximately 0.45m OD (Fig. 3.25). This depth was considered sufficient to accommodate both the moat and the ring-beam foundations. Excavation began in February 2000. The topsoil, alluvium and humified peats were removed by machine and excavation was continued by hand. All exposed timbers were exposed and lifted by hand.

Principal results

Although the majority of the evaluation area contained no archaeological material, there were potential archaeological deposits that needed to be examined. The majority of these proved to be nothing more than driftwood which had accumulated along the Northey 'shoreline', which may have been fringed with stands of alder carr (French 2001;

Figure 3.25. Trench VC1

Scaife 2001). As work continued, two features became more clearly defined.

The first appeared archaeological from the outset. It consisted of a series of horizontal logs of coppiced alder roundwood lying next to each other and forming the 'corduroy' pattern of a small walkway with an average width of approximately 1.5m and an overall length of 5m (Fig. 3.26). 'Corduroy' roadways are better known in continental Europe, at places like Biskupin, Poland, or at numerous sites in Lower Saxony (Hayen 1987). Its location so close to the Northey landfall suggests that it might have formed part of a pier or promontory, however, rather than a road. Certainly, the informality of its structure would not be appropriate to the traffic that a road or track might be expected to carry. Unfortunately only one layer of timber remained, although some pieces did display signs of woodworking. There were no vertical pegs, stakes, or substructure, all elements that would normally be associated with a corduroy road on the continent.

The second feature was somewhat different. It did not appear to be man-made, and resembled little more than a pile of driftwood (Fig. 3.27). However, closer examination during the excavation and lifting of the wood showed that some timbers may have been gnawed. The initial thought was that it formed part of a structure built by beavers – perhaps a lodge or dam – and this still seems the most probable explanation. A full analysis of the results is given by Maisie Taylor in Chapter 4.

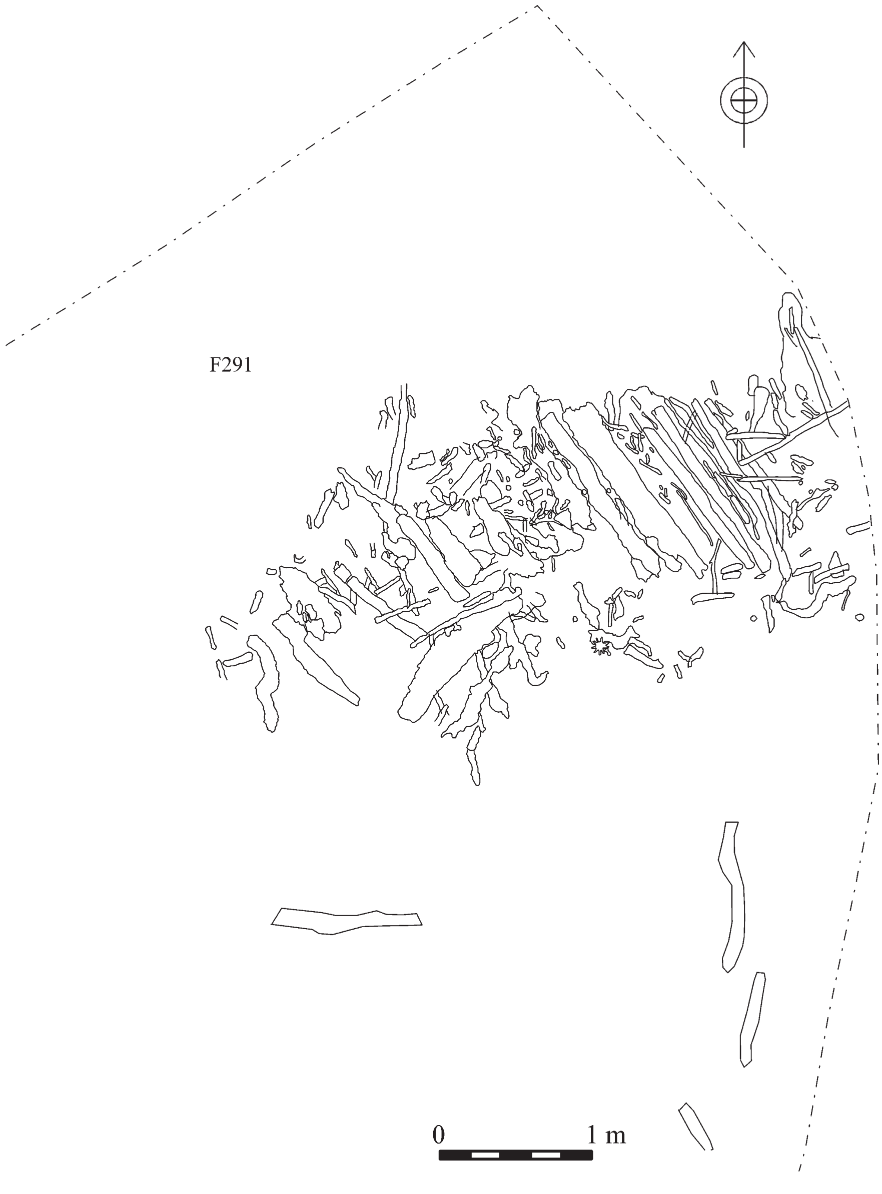


Figure 3.26. Corduroy walkway F291 in trench VC1

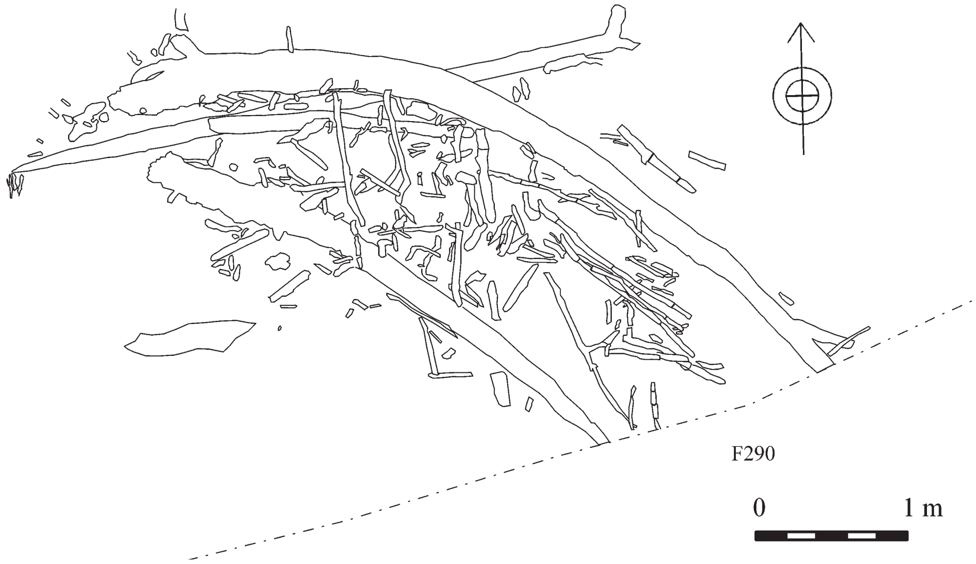


Figure 3.27. Beaver lodge F290 in trench VC1

Stage 4: the watching brief

The final stage of the archaeological work carried out during the construction of the new development took the form of a watching brief. Owing to the sensitive nature of the underlying deposits any ground-penetrating works were subject to close monitoring, and in an effort to pre-determine the nature of the deposits to be encountered a series of smaller test pits was excavated along the route of the service trench. These showed that the works would have no archaeological impact, given the relative shallowness of the proposed service trench.

Recent excavations at Northey: 5. The Northey landfall excavations (2003 and 2004)

Introduction

In addition to the contract excavations carried out at Flag Fen over the past eight years, training digs organised by the Fenland Archaeological Trust and funded by Anglian Water Plc have allowed continued exploration of the Northey 'shoreline'. These excavations were intended both to carry out further archaeological assessment (especially of preservation) and to provide an 'outreach' opportunity for students, volunteers and others to become personally involved in the project.

Up until 2001 work was concentrated on Area 6D (Fig. 3.6) within the lower wetland deposits to the west (Pryor 2001; Chapter 4, this volume) . However, in the summers of 2003 and 2004 new opportunities to assess the Northey shoreline became apparent due to forthcoming development works at Flag Fen. The aim of these excavations was primarily to determine the character, condition, significance and quality of any surviving archaeological material. However, with the advantage of results gained from the Green Wheel and *Time Team* excavations additional research objectives were specified as follows:

1. To ascertain the position and character of the fen-edge.
2. To look for further Beaker assemblages as found on the Green Wheel.
3. To pick up the continuation of a ditch heading for the post alignment found during Green Wheel/*Time Team* excavations.
4. To compare the level of degradation of waterlogged timbers with those found by *Time Team*.
5. To examine the buried soil horizons along the fen-edge, particularly taking into consideration the encroachment of peat, buried soil and the deposition gravels.

The excavations

Excavations were carried out for periods of six weeks each in the summers of 2003 and 2004. Three trenches were excavated: two trenches (2003/1 and 2003/2) excavated in 2003 were assigned site code FF03, while a single additional trench (2004/3) was assigned FF04 (Fig. 3.6). Once again, time was an issue. It was therefore decided to continue the strategy adopted during the Green Wheel excavations and target the largest sample of features possible in the allotted time. Any that could not be investigated were reburied and left *in situ*.

Archaeological horizons along the fen-edge

Excavation up to this point had established the presence of a more complicated common stratigraphic model than had been originally envisaged. These deposits seemed at first glance to have little that linked them together; they seemed

to vary considerably from one place to another, and buried soils seemed to have been constantly forming and degrading over time. The situation was made more complex because some were clearly 'living' surfaces that were subject both to natural and human manipulation and were consequently difficult to predict; this applied most particularly along the fen-edge, where the effects of erosion and deposition were magnified. Similarly, peat encroachment seemed to happen sporadically and could not always be predicted, even in lower-lying areas. Redeposited gravel has been identified along the fen-edge during recent excavations both at Northey and, further west, at Fengate. These gravels may have been deposited deliberately, to strengthen or reinforce ground surfaces at the wetland edge; alternatively, some may have been placed there by natural processes, such as flooding. Only soil science at the post-excavation stage can resolve these problems at all satisfactorily.

These were some of the issues that lay behind the tactics employed at the start of the 2003 season, when it was decided that each horizon should be fully investigated. This applied most particularly to the upper, often dried-out, horizons, which in the past could not be excavated by hand because of constraints imposed by time and funding. Each was fully recorded in 1m squares that were assigned unique context numbers. Although this approach was labour-intensive, it did allow the elaboration of a more comprehensive deposit model that included a series of common horizons which often included many contexts.

A total of thirteen horizons were identified; these comprised buried soil, redeposited gravel and peat horizons.

Trench 2003/1

Trench 2003/1 (Fig. 3.28) was opened adjacent to the northern bank of the Mustdyke, in order to see whether the Beaker activity recorded to the south-east could be detected here. In the event none was found; indeed, fewer features were found in this trench than any so far. One unexpected discovery was layers of numerous superimposed hoof-marks within a thickness of redeposited gravel (HzV, Fig. 3.29). It

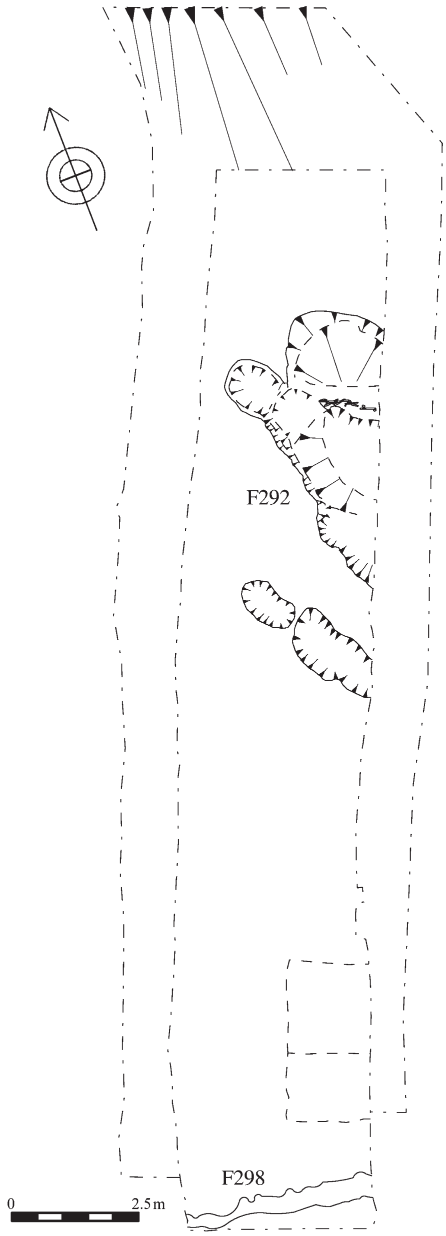


Figure 3.28. Trench 2003/1

Hz	*Description*	*Trenches present* 2004	2003	FFVC00	TT99	NTY99
XIII	Topsoil	Y	Y	Y	Y	Y
XII	Alluvium				Y	Y
XI	Fen Causeway Roman Road					
X	Peat II	Y	Y	Y	Y	
IX	Peat I	Y	Y	Y	Y	Y
VIII	Redep Gravel III		17			Y
VII	Upper Buried Soil	749	40			Y
VI	Redep Gravel II	747	170			
V	Lower Buried Soil	754	147		Y	Y
IV	Redep Gravel I	839				
III	Mottled Redep Gravel & B. Soil	840				
II	Prehistoric Archaeological Features					
I	Natural Gravel	Y	Y	Y	Y	Y

Figure 3.29. Identified Fen Edge Soil Horizons

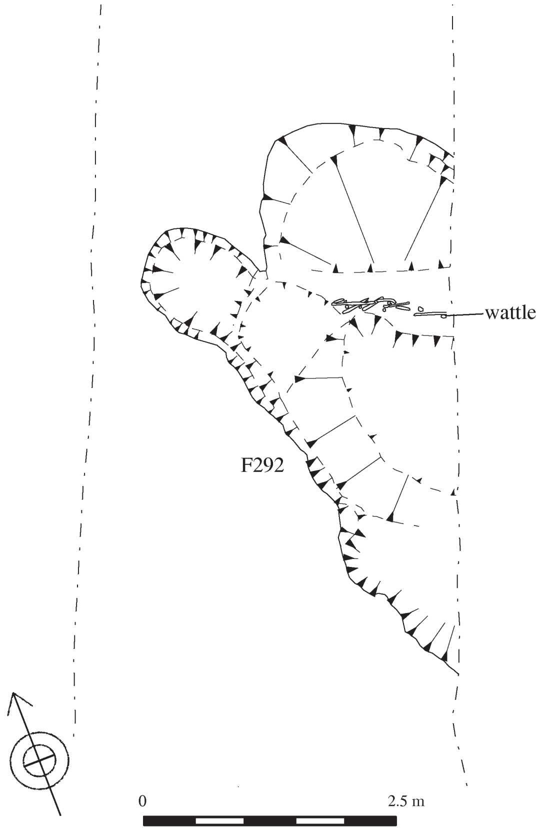


Figure 3.30. Feature 292

seems likely that this gravel had been brought from outside (possibly in the wetter condition that prevailed in the Iron Age) to stabilise the water's edge so that animals could approach to drink.

Seven features were recorded within this trench, including the edge of the adjacent Mustdyke (F298), the origins of which are known to lie in medieval times (Halliday 1986). The other six were all associated with the same feature: a watering hole on the fen-edge. This feature (F292) (Fig. 3.30) was a shallow scoop, irregular in plan and initially difficult to define. It soon became clear, however, as the filling was gradually trowelled-down, that it was in fact a multi-phased feature that had been enlarged over time. If it was indeed a watering hole or hollow, as was believed during excavation, then it was also clear that the depth of the water table would not have been a major consideration. This was confirmed by the discovery of collapsed wattlework which had probably tipped over and fallen on the bottom when the edge of the scoop (that had been terraced into the natural gravel) collapsed; this probably happened when conditions became wet underfoot. A scatter of possible post-holes around the watering hole might indicate that it had once been roofed or fenced off.

Trench 2003/2

This trench, which measured 33m×4.5m, was located directly adjacent to trench NT2, in an area where earlier trenches had found signs of prehistoric activity, in an attempt to reveal more about the Northey fen-edge. For this reason, trench 2003/2 was located between trench NT2 and the peat/gravel interface (Fig. 3.31). Following the removal (by hand) of the upper horizons, it was evident that both the post alignment and the ditch were present. The five rows of the post alignment visible elsewhere were quite clear, together with two additional, and smaller, peripheral fence lines to the north (F299–F302) and south (F939–F396 and F399–F402) (Fig. 3.18). The features of the various post alignment rows are given in Figure 3.32.

Trench 2004/3

This trench was positioned between trenches 2003/1 and 2003/2. The aim was to better understand the date and sequence of soil horizons, in particular the redeposited gravel.

The upper layers of topsoil (HzXIII, Fig. 3.29) and humified peat (HzIX and HzX) were removed mechanically to expose a dark brown sandy loam (HzVII) (buried soil) which contained a flint assemblage that was distributed across most of the trench. Below this, horizon VI was composed of redeposited gravel (747) which was broadly comparable to (170) of the previous year; both overlay HzV, the lower buried soil (2004/3/754 and 2003/1/147). A lower level of redeposited gravel, horizon HzIV (839), lay above a mixed buried soil and redeposited gravel matrix, horizon HzIII (840), which in turn capped the natural terrace gravel (HzI). Apart from the flints, no archaeological features were present in this trench, although a few root boles (F404–F407) were recorded for the archive. A series of modern pan-busting ploughmarks (F403) were also recorded; these cut through the upper horizons down to the natural gravel.

The two seemingly separate soil horizons recognised in the field probably represent an initial basal palaeosoil that was naturally truncated and degraded as water levels rose. A stabilising surface of dumped gravel was then added, upon which layers of organic material and peat accumulated, perhaps with some renewed soil growth. The large quantities of material (including both ballast and the finds within it) that was introduced during the process of stabilisation suggest considerable disturbance nearby, perhaps in the form of pit-, ditch- or bank-digging. The dating of this consolidation is difficult. Similar episodes of redeposition were noted in the Dyke Survey of 1982 further to the east, in Dykes 9 and 10 around the Padholme Pumping Station (French and Pryor 1993, 92–8). These deposits were also associated with flints and a prehistoric date seems probable. Alternatively, similar effects could also have been produced by disturbance associated with the digging, or cleaning out, of an as-yet-undiscovered precursor of the Mustdyke; or indeed by the modern pan-busting, the evidence for which

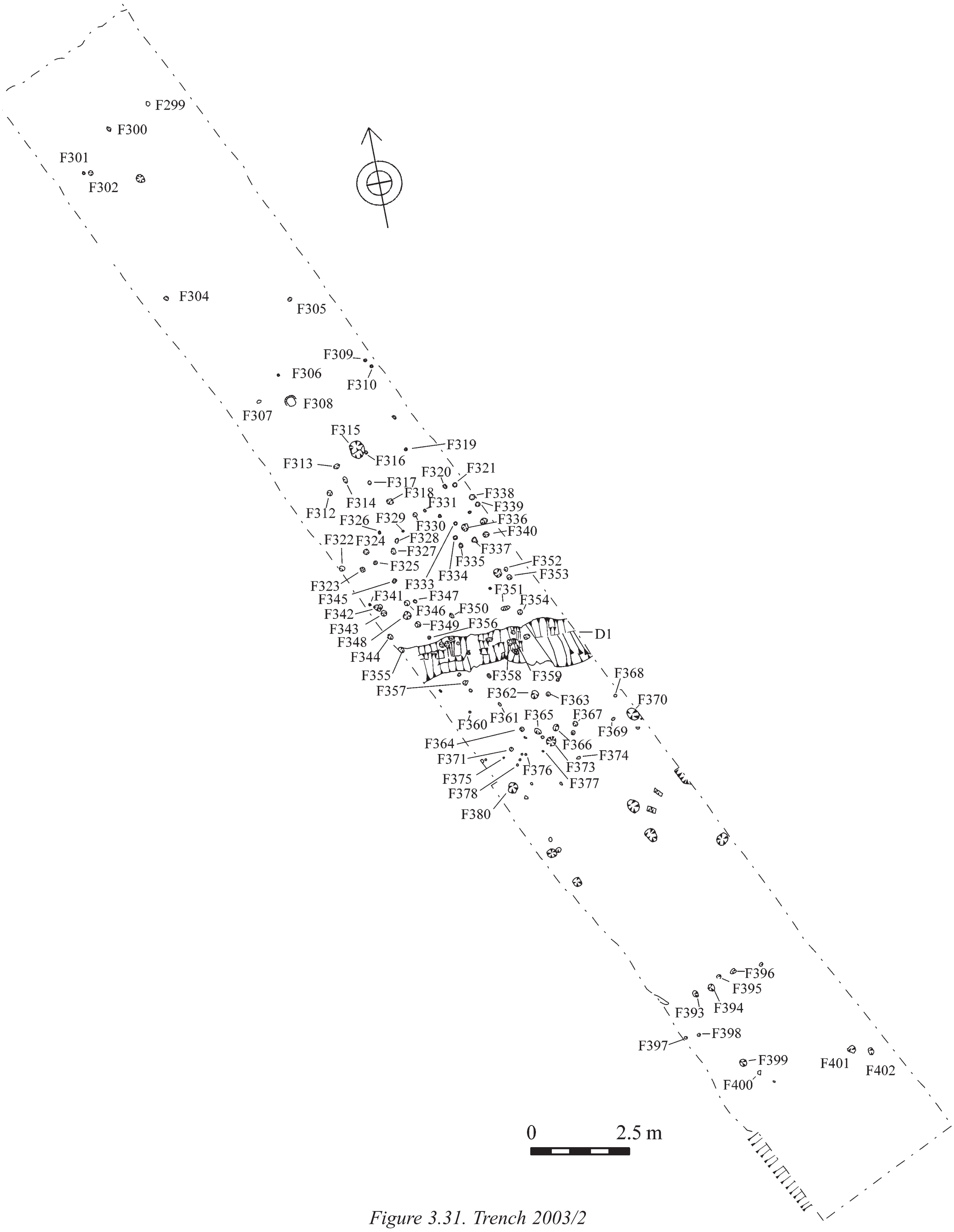


Figure 3.31. Trench 2003/2

Row 1	F360–F378
Row 2	F359–F355
Row 3	F354–F341
Row 4	F340–F322
Row 5	F321–F312

Figure 3.32. Post Alignment rows associated with trench 2003/2

was so apparent (we are grateful to Charles French for his views on these deposits).

Despite the lack of archaeological features, the 2004 season located the later prehistoric fen-edge, which was aligned south-west–north-east and included a possible inlet towards the north. Rather surprisingly, no Beaker material was found, which might suggest that earlier Bronze Age settlement had probably moved up the slope, further onto Northey 'island'. The ditch D1, whose upper filling was penetrated by the posts of the alignment, has clear comparisons with the Fengate side of the basin. A nearby pit, cut into the natural, contained Early Bronze Age pottery and flint, and was possibly associated with the ditch, which at the very least confirms the long-term importance of this routeway on the Northey side of the basin.

The precise origin of the gravel layers noted in this trench is uncertain, although a Late Upper Palaeolithic flint knife found within F292 is of particular interest as it indicates that at least some of the flintwork was clearly residual. A source in the Nene first terrace gravels, which occur at the very base of the trench and on Northey 'island' nearby, does, however, seem assured.

There is some other evidence to suggest that the gravel may have been redeposited in antiquity to consolidate a wet ground surface churned up by the trampling of animals' hooves (the bone assemblage shows signs of this). The presence of animals is confirmed by hoof-prints around the possible watering hole in trench 2003/1; a similar but slightly earlier example of this was found at Bradley Fen in 2004 (Gibson and Knight 2006).

Recent excavations at Northey: 6. Discussion

The purpose of this discussion is to draw the various strands of evidence together into a coherent picture. The main elements of the excavation will be approached period-by-period.

Neolithic

No proven features of Neolithic age were discovered, but it would be surprising if the wealth of Beaker and earlier Bronze Age material was imposed on a previously unoccupied landscape. Excavations in trenches NT1 and NT2 revealed a number of Neolithic flint implements, including serrated blades with diffuse silica lustre, long end-scrapers and a reworked polished flint axe. The lack of evidence for intensive Neolithic occupation at Northey need only reflect the relatively small scale of excavation to date, but it may also reflect the fact that the earlier Bronze Age settlement(s) were attracted to the area by the newly emerging wetter land of Flag Fen, where the lowest peats had begun to form, as we have seen, between 2030 and 1680 cal BC (Pryor 2001).

Earlier Bronze Age

Beaker pottery has been found along the fen-edge of the Flag Fen basin in pits and settlement features at Fengate (Gibson 1980; Pryor 1974, 35; 1993; 2001, 70–2), Vicarage Farm Road (Vaughan and Trevarthen 1998), Borougby Garage, further to the south (Pryor 2000a), and Edgerley Drain Road (Beadsmoore 2005). Beaker assemblages have also been recorded further south-east of the Northey landfall on the fen-edge at Bradley Fen (Gibson and Knight 2006).

Evidence for Beaker-period settlement was revealed on either side of the Mustdyke in 1999 in trenches NT1 and NT2, but was not found during subsequent seasons, even in adjacent excavations. The evidence, consisting of a series of pits and post-holes, only became clearly visible once the buried soil had been removed. While there was no unambiguous evidence for houses, such as circles of posts or possible paired porch post-holes, there were indications of hearths and burning with associated temporary structures. The Beaker features of trench NT1 were in two areas, to the north and south (Figs 3.11 and 3.12). The most remarkable aspect of the Beaker settlement was three clear rows of stake-holes within the southern area of NT1. The stake-holes were too irregular and slight to be parts of rectangular buildings. Rather, they formed clearly defined fence lines, within which were positioned small pits containing Beaker pottery and associated flints. Rows B and C ran roughly parallel to the edge of the wetter ground and there were possible entranceways into the area occupied by the four Beaker pits (F25–F28) in Rows B (between F16 and F18) and C (between F29 and F30).

The northern group of Beaker features was significantly different. Here small stake-holes appeared to cluster around larger pits and there were no signs of fencing. Evidence for fire and burning was apparent and it is possible that the associated stake-holes were the remains of roofed structures that may have sheltered or protected the hearths. While the generally ephemeral nature of Beaker structures has been noted in Britain (Simpson 1971; Gibson 1982; 1987; 1992; Thomas *et al.* 1986), there are no obvious parallels for the Northey structures – if, indeed, they are structures. The modest structures on the Northey landfall lie in contrast to more substantial Beaker dwellings located along the fen-edge, such as the stake-built circular dwelling at Hockwold-cum-Wilton (Bamford 1982) which, at almost 5m in diameter, is of similar size to the post-built circular dwelling at Bradley Fen, approximately 1.5km south of the Northey landfall (Gibson and Knight 2006), or the possible circular building at Site 11, Fengate (Pryor 1993). Closer parallels may be found at Easton Down in Wiltshire (Stone 1933), where a series of pits were encased by a circle of stakes. Alternatively, the Beaker features at Northey may be part of a more substantial but hitherto unlocated dwelling. For example, at Welland Bank Quarry, near Deeping St James in the lower Welland valley, a number of Bronze Age bowl-shaped hearths were located outside the roundhouses. They were often accompanied by settings

of post-holes similar to those found at Northey, along with some evidence for trampled floors (F. Pryor pers. comm.). The Welland Bank features may have been associated with salt-making, as briquetage was common and the environs of the small bowl-hearths were rich in charcoal. However, a similar hypothesis cannot at present explain the Beaker pits at Northey.

A less densely concentrated spread of Beaker period pits and post-holes was found on the north side of the Mustdyke, in trench NT2 (Fig. 3.13). The open pattern of pits and post-holes formed two loosely defined areas which probably represent different elements within the same broad settlement, rather than two discrete occupations (the fillings of the various features were remarkably similar). There was little or no evidence for inter-cutting and the post- or stake-holes did not appear to form coherent patterns or alignments. It would seem improbable that this settlement – if that is indeed what it was – included many substantial roundhouses or similar earthfast permanent structures. That said, we can by no means be certain that the two trenches discussed here were necessarily located anywhere near the centre of a settlement. Indeed, the positioning of the trenches so close to the edge of the permanently flooded fen would argue against there being much in the way of permanent settlement in this potentially flood-prone zone; one could suggest that permanent occupation would most probably have been located to the east, further up the slope of Northey 'island'. There is some evidence (*e.g.* Gurney 1980) to support this idea.

Cultural material (mainly bone and antler) was also found on the southern side of the dyke, at the old land surface, during the Dyke Survey of 1982 (Pryor 1993, 98). In that survey the Mustdyke was known as Dyke 10 and the nearest profile, which shows a series of cut features, was also Number 10 (French and Pryor 1993, 94–7). Profile 10 of Dyke 10 was taken about 180m south of trenches NT1 and NT2. The features, revealed in section included small pits and post-holes – a pattern similar to that seen in trenches NT1 and NT2. It is possible that all these features belonged to the same settlement, but they could also be a continuation of the Bronze Age 'midden' deposit encountered in 2003/4. If that is so, the hypothetical settlement would have been smaller, it is clear from the 1993 report that Neolithic material, including pits, is present. It now seems likely in the light of recent Northey excavations that some of this cultural material may be somewhat later – Bronze Age or even later Bronze Age. Even though the area settled along the fen-edge was large, it seems unlikely that it ever comprised a single coherent settlement.

The rows of post- and stake-holes associated with the small Beaker pits are of considerable interest. They may have formed internal partitions within a settlement, or, alternatively, they could have been a form of early land partition – precedents for the much better-known ditched fields of the later Early and Middle Bronze Age. Few parallels exist for such phenomena, but these 'fence lines' may prompt a reconsideration of other less-defined Beaker stake scatters, such as those at Swarkeston in Derbyshire, which were associated with a number of pit and hearth features (Greenfield 1960). Slight field or territorial boundaries 'reinforced' by offerings of metalwork were also a feature of the extreme fen-edge at Bradley Fen (Gibson and Knight 2006; Pryor 2003, 290–1).

Some of the Beaker sherds from Northey were quite fresh and unabraded. This suggests the possibility that they may have been deliberately broken and then deposited in pits. Something similar was observed at Fengate, where a series of pits located between the butt-end of two droveways near to the landfall were rapidly backfilled with 'fresh' beaker sherds, animal bones and flints (Pryor 1974; 1991, 519). It was suggested that these filled pits were a form of boundary marker. It is now recognised that the so-called 'industrial area' of the Newark Road sub-site was probably a dispersed burnt mound similar to those found at the fen-edge at Bradley Fen (Pryor 2003, 290–1); burnt mounds, like filled Beaker pits, were also positioned along boundaries such as the wet/dry transition at Northey, or indeed at Bradley Fen. It is possible that the presence of small fires at Northey was also associated in some way with such rites (Pryor 2001, 70–2).

By way of contrast, recent excavation of Beaker-period features near Edgerley Drain Road, Fengate, which were also located near to the fen-edge and a series of ditched droveways, demonstrated that many (but not all) of the pits there had been left open, silting and slumping over time; the pottery sherds within these features were 'generally quite weathered' (Beadsmore 2005, 24, 65). This does not necessarily rule out the 'boundary' theory, but it does suggest very different rites or activities.

The ditched fields of Northey 'island' have been less fully studied than their counterparts at Fengate, but double-ditched droveways were found at two locations east of Northey Road (Pryor 2001; Gurney 1980). The present excavations revealed no ditched droveways. Indeed, given the extent to which the western end of the post alignment extended up onto the gravel of Fengate, it was surprising that the Time Team trenches showed that the posts of the alignment only just crossed trench NT2, terminating a very short distance east, in the adjacent field. Geophysical and aerial photographic surveys revealed no evidence in that field for a ditch or droveway; in fact, the aerial photographs suggest that the ditch (D1) that was found below the posts in trench NT2 (Figs 3.16 and 3.18) was on a different alignment to that of the surrounding Bronze Age field systems. When excavation began D1 was thought to be slightly curved, but further excavation in 2003 showed it to be straight; despite its alignment it is still best interpreted as an earlier field or trackway boundary ditch. This would accord with the sequence noted at the Fengate landfall (the Power Station site), where posts of the alignment were also found driven into the filling of an earlier ditch (Pryor 2001, Fig. 4.4, 'Neolithic ditch').

The other probable Bronze Age field boundary ditch (D2) was found in trench NT3, below the gravel spread of the Fen Causeway Roman road, which provided a *terminus ante*

quem (Fig. 3.20). A low bank was found alongside it, to the south-east, which sealed a buried soil. A deep well, F268 (Fig. 3.17), was found close by D2 in trench NT3, while a second was found adjacent to the fen-edge in trench 2003/1. The dates of these features remains uncertain; Middle Iron Age pottery was found, but in contexts which suggest it was probably intrusive. Wells were often placed near field boundary ditches at Fengate and a later Bronze or Early Iron Age date would seem to be indicated.

Conjoining plain bodysherds of a large jar were found in F546 (context 574; cut 546, trench NT4). The fabric is probably Late Bronze Age and parallel material has been found at Welland Bank Quarry (F. Pryor pers. comm.). The feature in question is a shallow pit or scoop and it is just possible that it could have been associated in some way with salt manufacture, as were some of the vessels from Welland Bank. Such an explanation would fit with a location at the very edge of the wetland and would accord with earlier work at Northey, nearby (Gurney 1980).

Later Bronze Age

The metalled surface encountered along the Northey landfall in 2003 and 2004 is not a natural deposit that accumulated through the repeated rising and lowering of the water table. A number of explanations are possible and it should not be assumed that these deposits are necessarily prehistoric simply because they contained essentially Bronze Age flintwork. The presence of an Upper Palaeolithic flint clearly demonstrates that all these finds could have been residual, coming in with the gravel, just like the later Neolithic material that was dumped on paths and surfaces of the post alignment along with sand and gravel (Pryor 2001, 320–1). It must be remembered that the Fengate and Northey gravels were extensively occupied and by the mid-2nd millennium BC would have accumulated huge quantities of residual Neolithic and earlier Bronze Age flintwork.

With these caveats firmly in mind we might nonetheless tentatively suggest that the three layers of gravel interspersed with a thin lens of probable soil were undoubtedly dumped there and possibly deliberately. They probably derive from pits higher up on Northey 'island'. The presence of hoof-prints within the gravel and signs of damage caused by trample on the bone suggest that numbers of animals were present, possibly being packed together in a temporary enclosure or stock pen. This is the sort of place where livestock would have been corralled before or after being driven to fen pastures. Similar holding pens can still be seen on the edge of the flooded land of the RSPB Nene Washes Nature Reserve, near Dog-in-a-Doublet Sluice, Whittlesey.

It would seem that the edge of the dryland was used as an activity area quite extensively during the Late Bronze Age. Another later Bronze Age, but this time single-layer, redeposited gravel surface of some 71m×18m was revealed along the fen-edge at Edgerley Drain Road, on the Fengate side of the Flag Fen basin (Beadsmoore 2005, 13). This surface was largely devoid of debris, but debris from the Neolithic to the Iron Age was also recovered on the old land surface along the margins of Northey 'island' during the initial dyke survey that revealed Flag Fen (French and Pryor 1993, 94–7).

Although the ground surface may sometimes have required consolidation, the very edge of the dryland in the later Bronze Age might be seen as a form of midden which gradually acquired debris (Needham and Sørensen 1988). Broken and damaged bone, metalwork, pottery and flint and stone tools are commonly found within midden deposits at sites such as Potterne (Lawson 1994; 2000), Wallingford (Thomas *et al.* 1986), Runnymede Bridge (Needham 1991) and Shinewater Park (Greatorix 1995). The latter two sites were also located within wet/dry landscapes, and were associated with timber walkways and various votive deposits. Both, too, probably served as significant boundary points. Brück (1995; 2001) has argued that the incorporation of human bone in such deposits may have served to emphasise the importance of spatial or temporal boundaries, where it was appropriate to celebrate rites to do with renewal, regeneration or passage.

There is now accumulating evidence for the importance of livestock in the Bronze Age around the edges of the Flag Fen basin. The analyses of animal bone oxygen isotopes (Chapter 7, this volume) suggest that some animals, or at least parts of some animals, were being brought to the fen-edge for 'processing'. This is further indicated by cut and split marks on the bones, and the presence of scrapers and other flints that might have been used to process hides. The harness pieces coincide with the large number of horse bones (from animals which were old at death) from the bone assemblage. Feasting was certainly important at Runnymede Bridge and perhaps at Northey and Fengate too. Further evidence for long-distance contacts is provided by the single parallel of the bronze toothed buckle at Parc-y-Meirch in Denbighshire (Boughton, Chapter 8, this volume, no. 11).

Early Iron Age

The presence of pottery of probable Early Iron Age date was confined to a gravel 'floor' which sealed the posts of the post alignment in trench NT2. Twenty-two sherds were recovered, probably from the same vessel. This suggests that the material was indeed *in situ* and was not derived from residual sources. A somewhat larger spread of gravel was found to seal posts of the alignment at the Fengate landfall, where it was interpreted as a hard-standing, landing-stage or informal quay (Pryor 2001). Its location provides a *terminus ante quem* for the post alignment's Northey landfall.

Later Iron Age

Thirteen sherds of a wheel-made carinated bowl or jar were found from within desiccated peats in test Pit 11, trench NT1. This location is at some distance from the square ditched enclosure and it seems most unlikely that the pottery relates to activities that took place there.

4. Aspects of Wood, Timber and Woodworking at Flag Fen, 1995–2005

Michael Bamforth

Excavations of the waterlogged wood and timber from Flag Fen began in 1982, and were still continuing, but at a much reduced level, in 2005. The main English Heritage project ran from 1982 to 1992. This period of research concentrated on the post alignment at the Fengate landfall at the Power Station site, and along central sections of the post alignment and platform, which approaches the Northey landfall some 600m to the east. The wood recovered during this project is referred to as the 'A Series' and has been comprehensively published in the Flag Fen Basin monograph (Pryor 2001).

Privately funded excavations and research of a more limited nature continued within and adjacent to the previous (A Series) trenches from 1993 to 2001 in Area 6 (Figs 3.6 and 4.1). In 1999 the eastern extent of the post alignment was excavated as part of the Green Wheel project (Chapter 3, this volume). This drier environment revealed fewer wooden remains. *Time Team* also visited the site in that year, excavating a series of trenches along the eastern stretch of the post alignment between the Preservation Hall to the west and Northey 'island' to the east (Chapter 3, this volume). Additional trenches were also excavated along the western edge of Northey 'island', to the south of the previous trenches, in 2003 and 2004. Finally, in 2000 and 2005, small trenches were opened along the western (Fengate) length of the post alignment, largely to assess preservation and the effects of continued dewatering (Chapters 1 and 2, this volume).

This chapter will consider wood recorded after 1992. In the site archive and database it is recorded as the B and V Series. The new results will be compared with those from the A Series. This chapter will begin with a discussion of the impact of a serious fire at Flag Fen in 2000 which destroyed much of the archive relating to the post-1992 excavations.

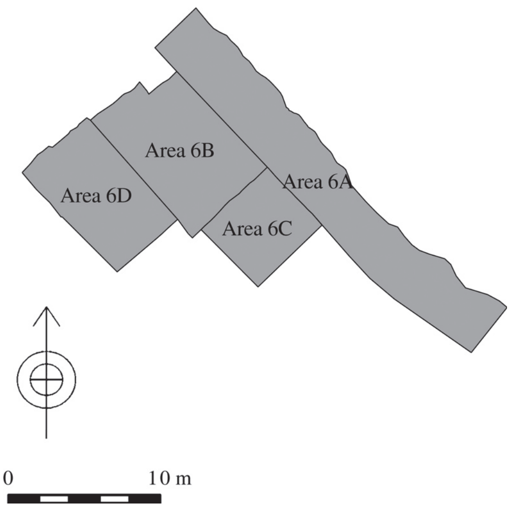


Figure 4.1. Area 6 sub-divisions.

The fire of January 2000

On 13 January 2000 a fire tore through the post-excavation building at Flag Fen with devastating consequences, destroying much of the archive stored therein. This section will outline the extent of the destruction and consider the effects the loss of the archive has had on the subsequent analysis of the site.

Fire damage to the archive

The fire almost completely destroyed the original timber record sheets from the entirety of the Flag Fen excavations. This primary resource was stored in a fireproof metal cabinet. At the height of the fire, the heat of the flames literally blew the doors off the cabinet. The only records to survive were those held in a nearby office, where they were being entered onto a database. The whole of the A Series had been entered into a database which survived the fire and, accordingly, the loss of the 'A Series' wood sheets, while inconvenient, has not been disastrous.

The destruction of the B Series timber record sheets has had more serious consequences. Although a Microsoft Access database holding much of this data survived, the process of data entry was still ongoing and a considerable amount of data had not been entered at the time of the fire. The B Series ran to a total of 5744 items. From this, 4779

records have been recovered from various sources. This represents a complete loss of 16.8% of the B Series wood archive, with many other records remaining incomplete.

The entire collection of completed, ink-drafted site graphics, including site plans and finds illustrations, were destroyed. This material had all been stored in a fireproof plan hanger at the time of the fire, which did not prevent it from being completely burnt. However, some of the original film 'permatrace' plans were stored in a series of old wooden plan chests that did survive the fire quite well. These plans were stacked on top of each other, with around 50 A2 sheets per drawer. In several cases, these plans were burnt and melted around the extremities, but much of the material survived. These melted 'tablets' of burnt plans were carefully peeled apart to reveal many surviving plans.

The phase of excavations covered by the A Series (Areas 1–8 and Area 6A) and Area 6B (forming part of the B Series) have been published in detail in the first Flag Fen Basin monograph (Pryor 2001). So again, although the loss of the graphic archive for this phase of works is unfortunate, it has not had a major impact on our ability to understand and interpret the site. The major loss from the fire in terms of graphics relates to areas 6C and 6D. Each area was excavated in six levels, meaning that a total of twelve excavation plans originally formed the basic graphic record for these areas. While the top level (Level 1) of areas 6C and 6D were also published in the first monograph, unfortunately, very few of the plans relating to the lower levels of areas 6C and 6D survived the fire. Survival of this material has been so poor that it has proved impossible to reconstruct the layout of timbers in these, admittedly limited, excavations.

Despite being held in metal filing cabinets, the entire slide and photographic archive for Flag Fen was destroyed by the fire. Over the years it has, however, proved possible to replace many of the key slides from the private collections of both project staff and others. The destruction of the dendrochronological samples precluded any dating of the B Series. The exact number of samples destroyed is not known, as the sample records were also destroyed in the fire.

Systematic laboratory identification of species via microscopic examination of sub-samples was carried out up to wood number B3028. Sadly, the destruction of all the species identification sub-samples from the remainder of the B Series has prevented this process from continuing. On the positive side, however, records of the original, non-microscopic, field identifications have survived in most instances. Identification in the field is reliable for oak and to a lesser extent for ash, but is more questionable for other species, such as alder, willow or poplar (Brunning 1996).

The longer-term effects of the fire

The damage caused by the fire has had a severe effect on research at Flag Fen. Although the first ten years of excavations at Flag Fen (the A Series) has been fully published, much of the unpublished data has been lost. The recent research on the platform from 1993 to 1999 suffered most severely. The graphic archive for areas 6C and 6D is so fragmented that any meaningful spatial analysis of the wood from these areas is impossible. Similarly, damage to the B Series wood archive has constrained the types of analysis it has proved possible to undertake.

Lessons learnt from the fire

The fire at Flag Fen has taught us many important lessons, some of which could well apply to other archaeological organisations faced with a similar disaster. In the immediate aftermath of the fire, new storage and working space had to be found to assess the surviving material. It was soon realised that work on the surviving archive material, owing to its fragmentary nature, had to be carried out by experienced archaeologists who were familiar with the assemblage. It could not be 'farmed out'. Experience soon showed that uncoordinated, albeit well-intentioned, help both in the immediate aftermath of the fire and later in the process could lead to further confusion.

One important lesson highlighted by the fire is the need to keep digital records up to date and secure. Back-ups should be stored in a separate location to the original files to guard against fire or other unexpected threats. The A Series data were held as a MS-DOS Maxarc database. Transferring this to a Microsoft Windows compatible format, although possible, proved extremely challenging. The process involved reconditioning an old computer capable of reading the 5½ inch floppy discs of the Maxarc database and then writing a program to convert the retrieved data to a Microsoft compatible format. These digitally obsolete records were usable, but disaster recovery would have been a much more streamlined process if the digital archive had been kept up to date.

The fire at Flag Fen has highlighted the fact that unexpected and serious accidents can and do happen. We have also learnt that in the immediate and longer-term aftermath a skilled and experienced team is needed to limit confusion and restore as much as possible. Although money could be found for a rapid assessment of damage, it proved almost impossible to find and fund a team until very much later, by which time some important data had been lost and the task was in any case much harder. An unpublished report into the damage caused by the fire was produced previously (Pryor 2000b).

A summary of previous work on wood and wood-working

By Maisie Taylor

The excavations and publications funded by the Royal Ontario Museum and Department of the Environment at Fengate from 1971 to 1978 are well covered in the original Flag Fen monograph (Pryor 2001). This overview of previous work also included the work and publications

of G. Wyman Abbott, Christopher Hawkes, Clare Fell and Isabel Smith, who all worked in the area from around 1900 onwards (Pryor 2001). Chris Evans of the Cambridge Archaeological Unit has subsequently carried out more detailed work on this early research (Evans *et al.* 2009).

Intensive archaeological excavation and research was carried out during the 1970s in response to the easterly expansion of Peterborough as part of the New Town development. These excavations revealed Bronze Age field systems with ditched fields and droveways. There was also evidence for a similar layout on the opposite side of the Flag Fen basin at Northey. These Bronze Age fields were organised for the management of large numbers of livestock, and enabled animals to be moved between wetter and drier seasonally available grazing. The fields appeared to have been laid out for the first time in the later 3rd and early 2nd millennium BC. At Newark Road the field system was complex, with fields, smaller enclosures and yards arranged around a major droveway. It was this droveway which, as it met the flooded land in the area of the Power Station, continued as five parallel lines of posts. These ran across the Flag Fen basin to the higher ground of Northey, forming the post alignment.

The earliest timbers in the post alignment were alder (*Alnus glutinosa*), and were probably felled locally. Alder continued to be used to some extent throughout the life of the monument. The other main species used extensively in the post alignment and platform was oak (*Quercus* sp.). A proportion of the wood was reused, and a number of artefacts were found, including a wheel and part of an axle.

Pottery from the Flag Fen and Power Station excavations included domestic wares and a significant number of complete vessels. Similarly, the bones were mostly domestic but included other material and an unusual number of dog skeletons.

The metalwork assemblage was particularly fine, and comprised around 275 objects from the excavations at Flag Fen and the southern part of the post alignment. Many of these items had been deliberately broken and smashed before being placed in the water. Some of this material dated from the Iron Age, suggesting that objects were still being deposited in the water long after construction and maintenance of the post alignment had ceased.

Five levels of horizontal wood could be defined in the deeper areas of the post alignment and there was some evidence for transverse timber and wattle 'partitions', which appeared to divide the alignment into segments of 5–6m in length. These segments seem to have played an important part in ritual activities at Flag Fen, and it is thought that they may have been used by different kin groups.

Charles French gave an overview account of the development of the prehistoric landscape in the Flag Fen basin which drew together all data available at the time (French 2001). His account spanned the period from the 3rd century BC to the medieval period. It showed how the landscape of Fengate slowly changed through prehistory as the mixed deciduous woodland gradually disappeared and extensive grassland developed. At the same time the field systems and droveways grew throughout the 2nd millennium BC and then contracted, culminating in the abandonment of most fields in the Iron Age. This process was also accompanied by a gradual shift from extensive to nucleated settlement. During the final two millennia BC flood meadows gradually spread inland, leading to peat growth and later to alluviation. The Flag Fen basin in the later 3rd millennium BC had a wide fringe of alder carr which gradually receded to be replaced by reed swamp and shallow open water. This was the time when the post alignment and platform were built. Maintenance ceased after about 900 BC as water levels continued inexorably to rise, a process that continued through the Iron Age. Finally, after a drier period in early Roman times, alluviation resumed in earnest, probably as a consequence of intensification of arable farming and land clearance in the upper reaches of the Nene; the alluviation may also have been increased by the introduction of winter wheats (Pryor 2001, 405–20).

The discussion of settlement and land use complements the account of environmental change, and has also brought up to date the understanding of prehistoric landscape change. Recent research suggests, for example, that the end of the Bronze Age ditched fields at Fengate was more gradual than previously believed. Some areas seem to have been abandoned before others, just as some came into existence after others. The fields around Storey's Bar Road are a case in point, being somewhat later and of shorter duration than those of the Newark Road sub-site immediately to the north (Evans and Pryor 2001).

Since the publication of the monograph much work has been done, both locally and further afield. Some of this is awaiting full publication while other sites have appeared in the 'grey' (client/contract) literature. For example, Archaeological Solutions excavated a site in Newark Road, Fengate, in 2005/6, which showed that the Bronze Age field system with its ditches and watering holes extended much further to the north than had previously been thought. Further afield, the Northamptonshire Archaeology Unit has excavated extensively in the fen just west of Thorney ahead of bypass construction. These excavations, which are awaiting publication, revealed a Bronze Age field system with fields, paddocks, droves and sheep-handling systems (Mudd and Pears 2008) as complex as and better preserved than those at the Newark Road Fengate sub-site (Pryor 1980). Nearby, but on the opposite side of the A47, Network Archaeology have uncovered a vast extension of the same system in the Pode Hole Quarry. This field system, although quite close to Fengate and Flag Fen, is in a different drainage system, on the north side of the Eye peninsular and Thorney island.

Cambridge Archaeological Unit has carried out several excavations in Fengate. Excavations on Elliot's Site in 2005 have produced firm evidence for the hedging of the field which had previously only been suspected (Pryor 1980, plate 15, fig. 128). The pieces of gnarled blackthorn (*Prunus spinosa*) from Elliot's Site had clearly been cut and

laid. When two samples of this material were submitted for radiocarbon dating they gave dates centring on 2000 cal BC, thereby pushing back the date for hedges and for hedge-laying in general (Evans *et al*. 2009). Other small excavations in Fengate by a variety of archaeological units have added various details to the picture.

Cambridge Archaeological Unit have also carried out major excavations at Bradley Fen on King's Dyke, Whittlesey, between 2001 and 2004. Although some distance away from Flag Fen by road, the two sites are intervisible across the fen (Pryor 2005, colour plate 30). Must Farm, which was excavated in 2006, is adjacent to Bradley Fen and has proved to be even more remarkable. While Bradley Fen is a fen-edge landscape and complements Flag Fen and Fengate, Must Farm is more completely waterlogged and preservation of both Late Bronze Age wood and other organic material is outstanding. Publication is eagerly anticipated.

Elsewhere in the country there have been large excavations which have also thrown light on waterlogged sites and landscapes in low-lying areas. Fine examples of flood-plain settlements may be seen at Yarnton (Hey in prep.), Cassington (*ibid.*) and Reading Business Park (Moore and Jennings 1992) in the Thames Valley, while post alignments not dissimilar to Flag Fen have been found at Fiskerton and Washingborough in Lincolnshire (Allen 2009) and Beccles in Suffolk (Field and Parker Pearson 2003; Taylor 2009b; Gearey *et al.* forthcoming).

Recent research into wood and wood-working

By Michael Bamforth

The excavation of wooden remains at Flag Fen can be broken down into two distinct phases based on the sampling strategy employed. During the early years of research at Flag Fen (1982–1992) a policy of 100% retention and analysis was used, with each item being planned, numbered and retained for further analysis. The *c.*9000 items recorded in this way along the dykeside exposure and in Area 6A form the A Series. The information gained during this period of 100% retention allowed the formulation of a sampling strategy which was employed for the B Series (Taylor 2001), and subsequently for all excavations after 1992.

Methodology

Although the A Series total collection and recording policy provided a wealth of data, it became clear that there was a high degree of redundancy and unnecessary duplication. Accordingly, for the B Series it was decided to expose a complete level of wood to reveal and define the individual elements. The exposed area was then planned and photographed. Next, individual elements were lifted separately and the plan numbered as necessary. All worked items were individually numbered and provisionally recorded in the field before being retained for further analysis (Taylor 2001). Woodchips and unworked roundwood were recorded as such on the plan and discarded. The exception to this was the 100% retention of woodchips and unworked roundwood from 1m sample squares which were positioned to sample and quantify 'background noise'.

All numbered items were individually recorded using the pro forma 'wood recording sheet' developed by Maisie Taylor (Appendix 3). All records were then entered into a database. Measurements in the field were made with rulers and tapes; toolmarks were measured with transparent rulers to a tolerance of 1mm. The system of categorisation and interrogation developed by Taylor (1998 and 2001) has been adopted for the present report. Wood identified to species by inspection (oak and ash) was noted. Other items were sub-sampled and identified to genus via microscopic identification as necessary.

As oak can reliably be identified by eye it will always appear to be predominant; this known sample bias must therefore be acknowledged and taken into account. In the case of the Flag Fen assemblage, oak generally represents more than half of the sample.

Condition scoring of material

The condition scale developed by the Humber Wetlands Project (Van de Noort *et al.* 1995) is used throughout this report (Fig. 1.1). The condition scale is based primarily on the clarity of surface detail. Material is given a score depending on the types of analysis that can be carried out given the state of preservation.

Where preservation varies across a particular piece, the best-preserved section is scored. Posts, for example, are often better preserved lower down. Upright posts that are recorded *in situ* are generally not scored for condition. In the majority of cases, only the highest surviving part of the post is revealed, and as the high point of upright posts represents the top of the preservation horizon, the wood is, predictably, much degraded. Therefore, such posts are scored only where a section of the post is visible below the area of extreme decay associated with the upper reaches of the preservation horizon.

Results from previous wood analyses

The wood analysis in the Flag Fen Basin monograph (Taylor 2001) focused on the two large assemblages that were then available for study: the Flag Fen A Series (Later Bronze Age) and Etton (Middle Neolithic). The results of this comparison are summarised below.

Statistical analysis showed that timber was generally longer than roundwood and that the original diameters (where these could be estimated) were mainly in the 80–200mm range, suggesting that only large pieces were selected for conversion into timbers. Roundwood was converted into timber by radial and tangential cleaving. The range of such conversions was exceptionally broad. Similarly, there was a wide range of joints and slots,

including mortise and tenon, halving laps and in the case of the wheel, hidden dowels. All finishing and trimming work was carried out with axes and occasionally gouges. Although no direct evidence for the hafting of axes as adzes has come to light in Britain, the extensive occurrence of hewing toolmarks suggests that it did happen.

It was concluded that roundwood as a category, whether worked or unworked (although excluding brushwood) was in itself a 'finished product'. The majority of the Flag Fen A Series roundwood assemblage (80.57%) was larger than 20mm, and was probably brought to Flag Fen in the form of poles and larger pieces. However, despite the bulk of the roundwood assemblage being suitable for use as structural components (such as wattle fencing) it was, for the most part, used to make up the level of the platform and support the walkways between the post rows.

The Etton woodchip assemblage tended towards squatter, shorter chips, while the A Series woodchips were generally longer, wider, and more slender. Cross-grained woodchips, an item not seen at Etton, were present at Flag Fen. It was concluded that these were the result of using metal axes, since they require a sharp edge and a high impact, right-angled blow to detach them. In short, it was concluded that the greater variability seen within the Flag Fen assemblage is itself a distinguishing characteristic of bronze rather than stone axes. Should a large assemblage of Iron Age woodworking debris be found, it would be useful to see whether this variability continues with even harder-edged tools.

Slabs and sapwood woodchips were under-represented in the Power Station assemblage in comparison to the platform assemblage. Sapwood loss was also noted from many of the upright posts of the alignment. This was caused by drying-out and other post-depositional circumstances. It is suggested that the nutrient-rich sapwood was subject to increased degradation by bacteria, fungi and other biological decay. It is also suggested that the fen-edge environment of the Power Station site was a higher energy environment, with more fast-flowing water and associated floods. A comparison of the Power Station assemblage with material recovered during recent excavations of the eastern stretch of the post alignment appears below.

Category	*Frequency*	*%*
natural roundwood	317	5.55
root	58	1.02
roundwood	3214	56.32
roundwood debris	72	1.26
timber	331	5.80
timber debris	101	1.77
debris	1614	28.28
Total	5707	100

Figure 4.2. Principal categories of wood and timber from Area 6A (A Series)

Analysis of the wood from Area 6

We have seen that the fire of 2000 has had a serious effect on our ability to study material from Areas 6B, 6C and 6D, particularly in terms of spatial analysis. An in-depth analysis of the A Series wood data from the adjacent areas of excavation has thoroughly characterised the make-up of the wood assemblage of the platform. The detailed research into the A Series assemblage can usefully be augmented by further examination of the B Series.

Woodworking in the A and B Series

Although the B Series wood data were not considered with the A Series statistics, some quite detailed reporting was carried out. The majority of the artefacts were published in the monograph (Taylor 2001); similarly, jointed timbers up to B4176, toolmarks up to B3628, and species identification up to B3028 were also fully described therein.

The sample

During the excavation of Area 6A (A Series) some 9000 pieces of wood were recorded, 5707 of which were categorised and analysed in the monograph (Taylor 2001) (Fig. 4.2). The A Series assemblage might be regarded as broadly representative of the wood that was deposited in antiquity, as no sub-sampling or discard took place until both metric and woodworking data had been recorded.

As we have seen, during subsequent excavations in Areas 6B, 6C and 6D (B Series) a degree of sub-sampling was employed. This entailed the discarding of all woodchips and unworked material after the plans had been produced and before detailed recording of individual items took place. Of the 5744 items that were numbered and recorded, 945 records were lost due to the effects of the fire. A further 32 items were classified as natural roundwood or root; 1370 items were woodchips and 407 were unclassified. These items are not covered under the sub-sampling strategy and have been excluded from the final analysis. This leaves a total of 2970 items for analysis (Fig. 4.3). The B Series assemblage could, therefore, be seen as broadly representative of the worked wood (excluding woodchips) deposited in antiquity – less, of course, the data lost in the fire. The surviving

Category	*Frequency*	*%*
artefact	20	0.67
roundwood	1600	53.88
timber	530	17.84
timber debris	563	18.96
debris	257	8.65
Total	2970	100

Figure 4.3. Principal categories of wood and timber from Area 6B, 6C & 6D (B Series)

material is considered as 'the assemblage'. Each principal category will be briefly discussed below, with reference to the A Series where appropriate.

Artefacts

The majority of the artefacts recovered as part of the B series have been published in the Flag Fen Basin monograph (Taylor 2001; see Fig. 4.4 for brief descriptions). The remainder are discussed by Maisie Taylor at the end of this chapter.

Roundwood

Some 1600 items, representing 53.88% of the assemblage, were classed as roundwood, making it the most abundant category. Some wood, such as the upright timbers of the post alignment, was classed as timber owing to its function, despite remaining 'in the round'. Although around twice as many items of roundwood were assigned to the A Series, the overall proportion is surprisingly similar in both series. As the B Series considers only the worked roundwood, this shows that the majority of roundwood recovered had evidence of woodworking.

Of the 1600 items of roundwood, 1040 were identified to species. There was a high prevalence of alder, a medium prevalence of oak and a low prevalence of willow/poplar, hazel, ash and willow.

The most common form of woodworking was trimming to length, working with an axe from either one or two directions. Removal of side branches also featured significantly. There was evidence for hewing of roundwood, often creating one or two faces, and for sharpening to a point from one or more directions; there were also a few cases of small notches being cut into the roundwood.

When the diameters of the A Series roundwood were taken, only items that had not been affected by post-depositional compaction were measured. In the case of the B Series, a slightly different approach was adopted. Here, the undistorted diameter measurements have been used in conjunction with a mean value (based on maximum and minimum diameters) of the distorted items. The extent of radial distortion of the B Series roundwood assemblage is discussed below.

The distribution curve for the diameters of the roundwood assemblage shows that the majority of the material (61.45%) falls between 20mm and 60mm (Fig. 4.5 and 4.6). These values broadly agree with the diameter of coppiced material as recorded from archaeological hurdles. This suggests that much of the material is derived from coppiced woodland (Fig. 4.7).

Wood number	*Description*	*Taylor 2001 reference*
B1970	axle roughout	218, 7.53
B2475	spearshaft	225, 7.62
B2476	tongue chape	228, 7.62
B2477	tongue chape	228, 7.62
B2653	axle	217, 7.52
B2737	haft – possible adze	221, 7.57
B2875	needle / bodkin	228, 7.67
B3130	possible flail	219, 7.54
B3249	hammer	222, 7.58
B3610	possible roughout for hub	216, 7.50
B3660	handle	225, 7.64
B3833	wheel	214, 7.48

Figure 4.4. Brief description of previously published artefacts

	Length							
	0-200	*200-400*	*400-600*	*600-800*	*800-1000*	*1000-1200*	*1200-1400*	*1400-1600*
Frequency	255	442	266	173	130	92	50	44
%	15.94	27.63	16.63	10.81	8.13	5.75	3.12	2.75
	Diameter							
	0-20	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*	*120-140*	*140-160*
Frequency	64	495	423	216	137	71	35	24
%	4.28	33.14	28.31	14.46	9.17	4.75	2.34	1.61
	Length							
	1600-1800	*1800-2000*	*2000-2200*	*2200-2400*	*2400-2600*	*2600-2800*	*>2800*	*total*
Frequency	31	20	21	15	14	9	38	1600
%	1.94	1.25	1.31	0.96	0.86	0.56	2.36	100
	Diameter							
	160-180	*180-200*	*200-220*	*220-240*	*240-260*	*260-280*	*>280*	*total*
Frequency	12	4	3	1	0	1	8	1494
%	0.80	0.27	0.20	0.07	0.00	0.07	0.53	100

Figure 4.5. Flag Fen B Series: roundwood dimensions (in mm)

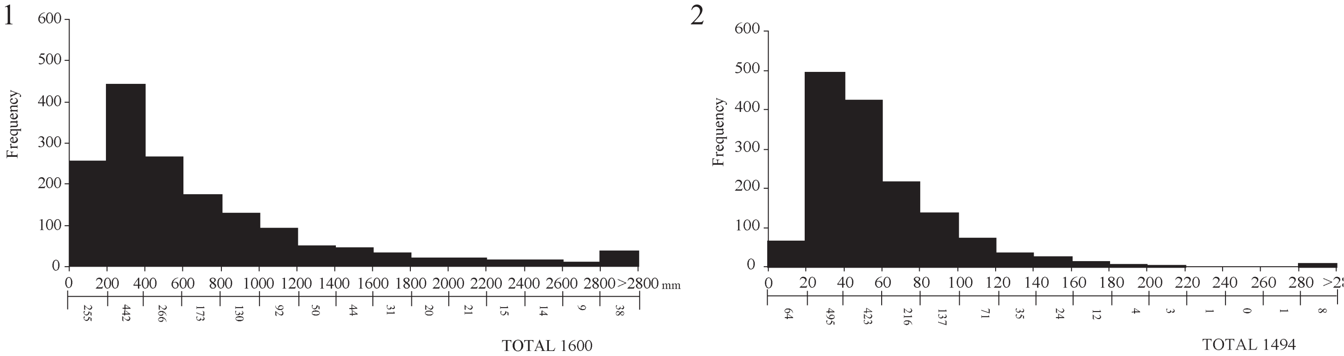


Figure 4.6. Flag Fen B Series roundwood, lengths (1) and diameters (2). Measurements in mm

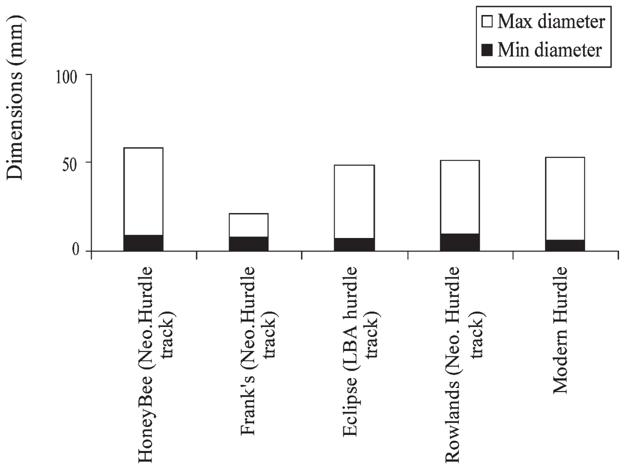


Figure 4.7. Range of coppiced roundwood diameters from recorded hurdles (after Taylor 2003, Figure 3.34: 47)

In all, 224 pieces of roundwood (7.54%) displayed morphological traits characteristic of coppice products. When the morphological data are taken with the metric data, it seems likely that much of the worked roundwood assemblage present within the Flag Fen platform was derived from coppice. Morphological traits associated with coppiced material include the presence of curved and flared 'butt ends' or 'heels', where the rod emerged from the coppice stool and the straight, even rods themselves, devoid of sidebranches and distinctly different from branch wood (Rackham 1977).

Taylor (2001) noted that the depositional circumstances of the majority of the coppiced material suggest that it had been used as make-up within the post alignment and platform. There are, however, two notable exceptions. A short length of *in situ* wattlework was seen in the western area of Area 6D, while the same area also contained about 2m of partially collapsed wattlework running approximately east–west across the axis of the post alignment. The plans of both these features were lost in the fire of 2000.

Timber

Of the 530 items designated as timber in the B Series, 177 were uprights of the post alignment. The remaining 353 items, which were found lying horizontally, were part of the platform make-up. As the post alignment timbers have a separate and distinct function, they will be considered separately, in the next section.

A total of 281 horizontal timbers were identified to species. There was a high prevalence of oak, moderate alder, occasional ash and a single item identified as *Prunus* sp.

Although the original diameter could only be projected for 58 items, a frequency distribution of the original diameters of the horizontal timbers has been included (Fig. 4.8 and Fig. 4.9). As we saw in the A Series, roundwood selected for conversion into timber was again much larger: the majority of items fall in the 80–200mm range, an exact match with the A Series.

Radial splitting was clearly preferred (209 items), with conversions ranging from ½ to 1/16 clefts. There was a smaller but still significant number of tangential splits (82 items) and a single piece had been converted to a boxed heart. There was also a high incidence of trimming to length, with items trimmed from one or more directions with an axe. There was a moderate preference for hewing, both in terms of split surfaces being 'cleaned up' and items being shaped and worked by hewing alone.

The joints present in the majority of the B Series timbers have been discussed in some detail by Taylor (2001) but, for the sake of completeness, a brief summary is provided in Figure 4.10. It should finally be added that we have still not recovered evidence for the use of tree nails, pegs or lashing at Flag Fen.

Timbers of the post alignment

Excavations in Area 6 recorded a total of 273 upright posts set in an east–west alignment and broadly arranged in five parallel rows. A total of 96 of these were from Area 6A (recorded as part of the A Series) and 177 were from areas 6B, 6C and 6D (recorded as part of the B Series). As they are all part of a coherent structure and have not previously been

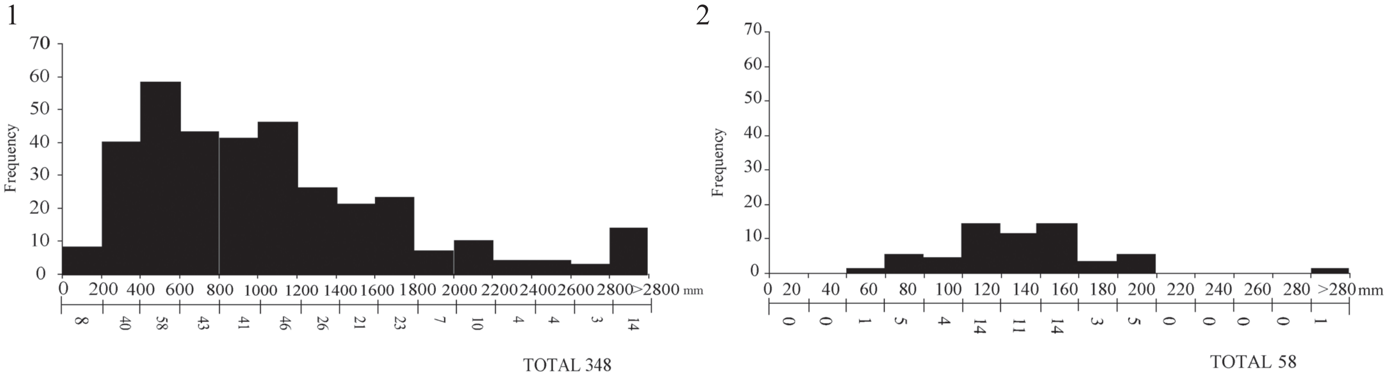


Figure 4.8. Flag Fen B Series: horiziontal timber lengths (1) and original diameters (2). Measurements in mm

	Length							
	0-200	*200-400*	*400-600*	*600-800*	*800-1000*	*1000-1200*	*1200-1400*	*1400-1600*
Frequency	8	40	58	43	41	46	26	21
%	2.30	11.49	16.67	12.36	11.78	13.23	7.47	6.03
	Diameter							
	0-20	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*	*120-140*	*140-160*
Frequency	0	0	1	5	4	14	11	14
%	0.00	0.00	1.72	8.62	6.90	24.14	18.97	24.14
	Length							
	1600-1800	*1800-2000*	*2000-2200*	*2200-2400*	*2400-2600*	*2600-2800*	*>2800*	*total*
Frequency	23	7	10	4	4	3	14	348
%	6.61	2.01	2.87	1.15	1.15	0.86	4.02	100
	Diameter							
	160-180	*180-200*	*200-220*	*220-240*	*240-260*	*260-280*	*>280*	*total*
Frequency	3	5	0	0	0	0	1	58
%	5.17	8.62	0.00	0.00	0.00	0.00	1.72	100

Figure 4.9. Flag Fen B Series: horizontal timber lengths and original diameters (in mm)

analysed (and their collection has not been affected by a sub-sampling strategy), they will be considered here together.

Although all the upright posts were sub-sampled for species identification many of the records were lost in the fire prior to inputting into the database, with the result that 17.95% (the majority of the non-oak material) of the uprights were not identified to species. In terms of species selection, oak clearly dominates the assemblage of identified uprights (Fig. 4.11), with a moderate occurrence of alder, ash and willow/poplar. Some hazel/alder was also recorded.

The loss of data in the fire becomes of some significance when we consider the distribution of species within the different rows. It is known, for instance, that the earlier Row 1 was formed almost exclusively of alder, with the occasional oak (Pryor 2001). The other, broadly contemporary, Rows 2–5 were all dominated by oak, although Row 4 contained the greatest diversity of species.

Row 1, the earliest part of the structure, resembles the lowest (earliest) layers of the platform, in that alder dominates. As time passed, the later rows and the higher (later) levels of the platform become increasingly dominated by oak (Fig. 4.12).

Joint type	*Frequency*
mortise	38
lap joint	17
slot	3
housing lap	3
notch	3
unclassified	1

Figure 4.10. Flag Fen B Series horizontal timbers, frequency of joints

The diameters of unconverted posts are given as the original diameter of converted (split) timbers where possible (Fig. 4.13 and 4.14). The diameter of the unconverted posts of the alignment are broadly equivalent to the original

	Row 1	*Row 2*	*Row 3*	*Row 4*	*Row 5*	*Total*	*%*
alder	2	3	20	5	0	**30**	10.99
ash	0	2	12	9	0	**23**	8.42
oak	2	34	60	45	10	**151**	55.31
hazel / alder	0	0	0	0	3	**3**	1.10
willow / poplar	0	0	8	7	2	**17**	6.23
not identified	8	5	24	10	2	**49**	17.95
Total	12	44	124	76	17	**273**	100

Figure 4.11. Flag Fen Area 6: frequency of species within within post alignment

	Row 1	*Row 2*	*Row 3*	*Row 4*	*Row 5*
alder	16.7	6.8	16.1	6.6	0
ash	0	4.5	9.7	11.8	0
oak	16.7	77.3	48.3	59.2	58.8
hazel / alder	0	0	0	0	17.6
willow / poplar	0	0	6.5	9.2	11.8
not identified	66.6	11.4	19.4	13.2	11.8
Total	100	100	100	100	100

Figure 4.12. Flag Fen Area 6: species across post alignment rows (%)

	Diameter							
	0-20	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*	*120-140*	*140-160*
Frequency	0	0	5	4	12	24	18	26
%	0.00	0.00	4.10	3.28	9.84	19.67	14.75	21.31
	Original diameter							
	0-20	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*	*120-140*	*140-160*
Frequency	0	0	0	0	0	0	5	1
%	0.00	0.00	0.00	0.00	0.00	0.00	18.53	3.70
	Diameter							
	160-180	*180-200*	*200-220*	*220-240*	*240-260*	*260-280*	*>280*	*total*
Frequency	9	7	8	6	1	1	1	122
%	7.38	5.74	6.56	4.91	0.82	0.82	0.82	100
	Original diameter							
	160-180	*180-200*	*200-220*	*220-240*	*240-260*	*260-280*	*>280*	*total*
Frequency	2	7	1	2	1	4	4	27
%	7.41	25.93	3.70	7.41	3.70	14.81	14.81	100

Figure 4.13. Flag Fen, Area 6: upright post diameters and original diameters (in mm)

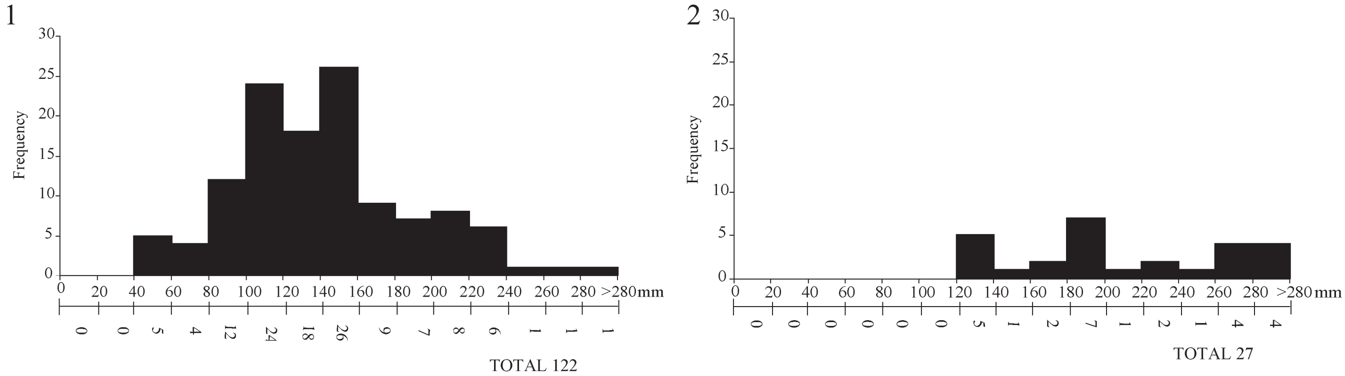


Figure 4.14. Flag Fen, Area 6: upright posts diameters (1) and original diameters (2). Measurements in mm

	Row 1	*Row 2*	*Row 3*	*Row 4*	*Row 5*
unconverted	83.3	34.1	69.4	65.7	47.1
tangential	0	20.5	8.9	5.3	23.5
radial	16.7	45.4	21.7	27.7	29.4
unclassified split	0	0	0.8	1.3	0
Total	100	100	100	100	100

Figure 4.15. Flag Fen, Area 6, upright conversions

	Row 1	*Row 2*	*Row 3*	*Row 4*	*Row 5*	*Total*
Total number of uprights recorded	12	44	124	76	17	**273**
Length exposed in metres	20.32	19.04	15.18	11.24	6.42	
Mean uprights per metre	0.59	2.31	8.16	6.76	2.65	**20.47**
Total posts assuming 1068m length	630.12	2467.08	8714.88	7219.68	2830.20	**21861.96**

Figure 4.16. Estimated total number of posts utilised in the construction of the post alignment

diameters of B Series converted timber: the majority of the material in both cases is between 80–200mm, although the post alignment uprights as a group do contain a greater percentage of larger (>200mm) items. These figures suggest that the trees that were split down and converted into timber in the platform and the trees used for the unconverted posts of the alignment were of a similar size.

The original diameters of the converted alignment posts clearly show they were derived from the largest trees represented in the Flag Fen wood assemblage, and possibly the largest trees available to be exploited for building material. Although it was only possible to project the original diameter of 27 timbers, all are >120mm in diameter. When choosing raw material for the alignment posts, there was also a clear bias towards larger trees. Taylor (Chapter 5, this volume) provides a detailed discussion of the role of large trees at Flag Fen.

Certain trends can be seen in the splits needed to convert such large baulks into timbers, ranging from radial ½ to ¼ splits. The conversion of posts utilised in Row 1 was distinctly different from that of the other four rows: there was more unconverted timber in Row 1, radial splits were fewer than in Rows 2–5 and tangential splits were absent (Fig. 4.15). Of the other four rows, Rows 2 and 5 (the outliers of the later structure) are also seen as broadly similar in function, both having stretches of wattlework constructed along them (Pryor 2001). Rows 2 and 5 have the lowest prevalence of unconverted posts and the highest prevalence of tangentially split posts. Rows 3 and 4 appear markedly similar: both include many unconverted posts, while radial splits are common, but tangential rare. The general patterns of roundwood conversions across the five rows emphasise the separateness of Row 1 and highlight similarities between Rows 2/5 and 3/4.

All posts, regardless of the rows in which they occur, have pointed tips characterised by very similar woodworking styles. Almost all have been trimmed from all directions to a tapered point with an axe. A variety of degrees of finishing has been noted, with some posts appearing very 'rough', while others were relatively highly finished. This style of woodworking would appear to be almost ubiquitous when large timbers to be pile-driven into the ground were given long, pencil-like points. Almost identical examples have been seen in Bronze and Iron Age contexts (Greatorix 1995; Taylor 2003).

Finally, it is now possible to offer a more accurate estimate of the number of posts involved in the construction and subsequent maintenance of the post alignment over a period of some four centuries. This crude projection assumes an even density for each row along the length of the structure and is based on the uprights present in Area 6. Our current 'best guess' suggests a figure of some 21,862 posts (Fig. 4.16).

Axes, toolmarks and tool faceting

Tool facets

When wood is worked with edged tools, evidence of that working is left on the surface of the wood in the form of tool facets. Usually when an edged tool, such as an axe or adze, cuts into wood, a piece (a woodchip) is removed and a tool facet is created. Sands (1997, 11) describes a tool facet as the 'product of a single strike of a tool', defined by 'either surrounding unworked wood or by the raised areas formed at the junction between successive blows of the tool'. Tool facets can terminate in a toolmark, which is created when a misjudged blow causes the edge of the tool to become stuck in the wood. Although toolmark is a widely accepted term, such features are also referred to as jam features, jam curves (O'Sullivan 1991, 61–2 in Sands 1997, 11; Sands 1997, 11) and stop lines (Allen 1994, 4). When a tool becomes stuck in the wood, the resulting tool mark should be a representation of the exact shape of the tool that produced the mark. Previous research at Flag Fen has highlighted the fact that the corpus of measured toolmarks is generally some 10mm smaller than a comparable corpus of

measured local contemporary axe blades. This discrepancy is consistent and suggests that the wood has shrunk slightly after deposition.

Tool signatures occur when a blade is nicked or damaged; this can leave either ridges or grooves which are aligned along the long axis of the tool facet as the damaged blade passes through the wood. Although many tool signatures were noted across the assemblage as a whole, their occurrence was deemed too rare to justify detailed recording.

Similarly, the size and nature of the tool facets themselves has not been recorded in a systematic, formal manner at Flag Fen. Although some (O'Sullivan 1991, 61 in Sands 1997, 12) argue that the largest facets on an item represent the relative ability of the tool to remove a woodchip, this is clearly an over-simplification. At Flag Fen, for example, different sizes and forms of tool facet have been noted in association with the same size of tool mark. This suggests that the size and form of a tool facet is related not only to the tool being used, but also to both the intention and the ability of the woodworker to detach a woodchip. As such, the measuring of tool facets has proved to be of little use at Flag Fen, where the axes used appear to be very similar to one another. The tool facets seen at Flag Fen are generally relatively small (*c.*30–50mm wide) and scooped or dished in profile. This is unsurprising considering the relatively narrow, curved blades of the socketed bronze axes that toolmark evidence suggests were used throughout the construction of the monument.

Toolmarks

During the earlier period of research at Flag Fen, all toolmarks were carefully traced out and collected together in group illustrations, arranged by series and level (Taylor 2001, 194–7). Following analysis of this assemblage it was realised that only the width and depth measurements were needed. Accordingly, toolmarks from the later stages of research were recorded using a pair of transparent hand rulers, working to a tolerance of 1mm.

Previous work on the toolmarks from Flag Fen has focused on a comparison between data collected from the upper and lower horizontal layers of the wooden platform. The original work aimed to test whether there had been a change in tool size or type over the construction period of the monument, and concluded that the same type of tool was used throughout construction. The toolmarks were assessed by width and toolmark blade-curvature index; the results of this analysis from Area 6 excavations (A and B Series) are given in Figures 4.17 and 4.18.

As the original analysis of toolmarks involved a comparison of earlier (lower) and later (higher) material, information on the unphased uprights was excluded. As the upright posts of the alignment pass vertically through the construction layers of the platform, it is often unclear as to which phase they belong. Subsequently, however, all posts from the main areas of excavation have been lifted and recorded, and there does not seem to have been any obvious difference between the types of tool used. With this in mind we will now attempt a comparison between the toolmarks from the post alignment and the platform.

All toolmarks from posts of the alignment (A and B Series) have been considered. They comprise a total of 39 toolmarks from 273 timbers. This can be compared with the 168 toolmarks from horizontal elements of the platform (in Areas 6A and 6B). The platform material was grouped into an upper assemblage (from 0.89m to 0.30m OD) which comprised 83 toolmarks, and a lower (from 0.29m to 0m OD) of 85. As there is still no overall study of southern British bronze axes, the toolmarks were compared with Sands' (1994) dimensions and profiles of north British bronze axes extracted from Schmidt and Burgess's (1981) published corpus and Davey's (1973) corpus of Lincolnshire Bronze Age metalwork.

Statistical analysis of the toolmarks found on horizontal timbers in Areas 6A and 6B strongly suggested that the same axe type was in use throughout the construction of the platform, as little difference was observed between the upper and the lower levels. Indeed, both the width and the blade curvature indices were a close match for bronze socketed axes. The closest match was found to be with socketed axes of the Yorkshire type (Taylor 2001, Fig. 7.29).

When toolmarks from the B Series horizontal timbers of Areas 6C and 6D were compared with similar timbers of the A Series (in Areas 6A and 6B) the blade width measurements were found to be very similar, but when the curvature indices of the same two data sets were compared there was slightly more variation: in the case of the B Series, both the maximum curvature index and the standard deviation were lower. This is somewhat surprising given the greater size of the B Series data set, which one might expect would result in greater range and variation. That being noted, the differences in blade curvature index of the two data sets do not seem large enough to suggest that different types of tool were being used in the two areas. Again, it still seems most likely that all the timbers were worked with bronze socketed axes.

A comparison of toolmarks on the upright posts from Area 6 with those on horizontal material from the same area suggests a similar picture. Average blade width was again comparable, although there was less variation in maximum and minimum blade widths. This is unsurprising given the much smaller sample from upright posts. A comparison of blade curvature indices also shows the two assemblages to have been very similar; once again, there is less variation in the smaller assemblage from the posts than in that from the horizontal timbers. As before, it would seem that the same tool types were being used for the shaping of the alignment posts and the construction of the platform.

Timber debris

The 563 items of timber debris amount to 18.96% of the assemblage and represent the second most abundant class of material. In total, 411 items were identified to species; there

Toolmark	*Wood series*	*Average blade width (mm)*	*Standard deviation of blade width*	*Minimum blade width (mm)*	*Maximum blade width (mm)*	*Number of items in calculation*	*Sources*
Flag Fen areas 6A (all horizontal)	A series	38.06	6.83	15	55	168	
Flag Fen areas 6A (upper horizontal)	A series	38.06	6.12	15	52	83	
Flag Fen areas 6A (lower horizontal)	A series	33.06	7.50	15	55	85	
Flag Fen Uprights area 6	A & B Series	36.92	6.23	20	46	39	
Flag Fen areas 6B, 6C and 6D (all horizontal)	B Series	36.29	7.65	15	55	301	
Axe type							
Wilburton		42.67	5.25	38	50	3	Sands 1994
south-eastern		43.00	7.11	24	52	30	Sands 1994
Yorkshire		46.59	4.59	32	58	211	Sands 1994
socketed		47.44	4.73	27	63	170	Davey 1973
all flanged and palstaves		55.71	12.49	24	87	70	Davey 1973
flat and low flanged		60.60	13.22	36	78	20	Davey 1973

Figure 4.17. Comparison of blade widths: Flag Fen toolmarks and selected Bronze Age axe types

Toolmark	*Wood series*	*Average curvature index (%)*	*Standard deviation of curvature index*	*Minimum curvature index (%)*	*Maximum curvature index (%)*	*Number of items in calculation*	*Sources*
Flag Fen areas 6A (all horizontal)	A series	14.83	7.03	0	60	168	
Flag Fen areas 6A (upper horizontal)	A series	16.18	7.86	2.94	60	83	
Flag Fen areas 6A (lower horizontal)	A series	13.52	5.87	0	30.3	85	
Flag Fen Uprights area 6	A & B Series	14.05	4.73	5	24.39	39	
Flag Fen areas 6B, 6C and 6D (all horizontal)	B Series	13.77	6.50	0	48.48	301	
Axe type							
Wilburton		17.81	6.35	11.25	26.4	3	Sands 1994
south-eastern		17.04	6.52	4.41	35.87	23	Sands 1994
Yorkshire		14.54	6.53	1.3	34.09	163	Sands 1994
socketed		19.18	7.34	0	35.29	170	Davey 1973
all flanged and palstaves		24.79	7.57	10	45.45	70	Davey 1973
flat and low flanged		24.90	9.28	7.69	47.06	20	Davey 1973

Figure 4.18. Blade curvature indices: Flag Fen toolmarks and selected Bronze Age axe types

was a high prevalence of oak (281), a moderate presence of alder (100) and occasional ash (30). This pattern is remarkably similar to that of the finished timber (described above).

The large quantity of woodchips suggests *in situ* woodworking over most or all of the site. The main issue with regard to the timber debris is whether the material was deposited as a by-product of *in situ* woodworking, or whether (as seems to be the case with much of the roundwood) it has been brought to the site as make-up.

When comparing the A Series assemblage with Neolithic wood from Etton, Taylor (1998) argued that the original purpose of a site will radically affect our appreciation of the wood. At Etton, much of the roundwood was waste, a by-product of converting raw material (roundwood) into finished items such as hurdles. At Flag Fen the story seemed very different, with much of the roundwood being imported to the site as a product in itself, to be used as make-up within the platform. As we have seen, the woodchips indicate *in situ* woodworking on the platform – presumably some of this woodworking was the shaping, reduction and finishing of the numerous timbers that still survived. These processes of reduction would of course have produced timber debris (off cuts). However, there is a large volume of timber debris present within the platform and it seems likely that at least some and possibly much of the debris was brought to the structure as a product in itself, to be used as make-up within the platform. This is a potential case of a material that would normally be viewed as waste being utilised as a secondary product, and supports Taylor's assertion that we should always bear in mind the purpose of a site when analysing the wooden remains it contains.

Wood from excavations at the site of the moat for the New Visitor Centre

By Maisie Taylor

Introduction

The only wood excavated as part of the Green Wheel project came from the security moat of the New Visitor Centre. This wood was well away from the post alignment, but not far from the Northey fen-edge (Fig. 3.6).

The Visitor Centre moat

Work on the Visitor Centre moat was in two phases. Half of the moat was excavated in advance of construction and two main concentrations of wood were identified (Fig. 3.25). In total, sixty-six pieces of wood were numbered and sampled, or recorded in detail. Most of these lay between 0.31 and 0.67m OD and were, generally, not in particularly good condition, as is partially reflected by the heavily distorted diameters of the roundwood. The compression of roundwood diameters was found at Etton to indicate drying-out (Taylor 1998, 138).

The possible pier or landing-stage

Some of the wood appeared to form a pier or short trackway (Fig. 3.26). Most of the wood here was too decayed for detailed analysis, but five samples were taken from better-preserved material, all of which were alder (*Alnus glutinosa*). They were laid straight onto the ground (*i.e.* with no bearers) at levels that ranged between 0.55 and 0.60m OD. This is a higher level than the 'beavered' wood described below. All of these pieces were trimmed, with the possible exception of one whose ends were heavily decayed, and all was extremely dried-out with highly distorted diameters which averaged between 38 and 85mm. Some roundwood of smaller diameter was laid parallel to the large pieces, but this was all too decayed to produce any reliable data, although it would have added to the effectiveness of the structure.

Beaver-modified wood from excavations at Flag Fen

The tooth-marks of beavers are quite distinctive and are easily distinguishable from tool-marks. Beaver-chewed wood from the Flag Fen platform has been compared with modern wood modified by Canadian beavers (kindly supplied by Charles French). In total, ten or more pieces of beaver-modified wood have been found during previous excavations at Flag Fen. All were from low levels (0.04–0.29m OD). Excavations for the moat of the Visitor Centre produced a further ten pieces of beavered wood. These pieces came from higher deposits (0.45–0.54m OD).

In every case, the wood was alder (*Alnus glutinosa*), a favourite food for beavers. One piece from the research excavation was quite large (compressed diameter 80/95mm, and over 2m long). It had been originally cut from a coppice stool with an axe, and the stem had been chewed half through by beaver. It is quite possible that the stem was chewed by the beaver while still growing and was then removed from the stool with the other poles when the coppice was cut. All the other pieces from the research excavation (Area 6), plus the material from the Visitor Centre moat, were much smaller in length and diameter. Most of the wood from the research excavation had distorted diameters, perhaps because they were extracted from low in the platform. The material excavated from the Visitor Centre moat also has distorted diameters but this was largely because it had dried out. The estimated undistorted diameters from both areas range from 20mm to 50mm. The research excavation produced two pieces which had been worked by both humans and beavers. None of the new material was modified by both beavers and humans, although wood modified by beavers lay close to wood which had been axe-trimmed.

During the second phase of the construction of the moat, little wood was observed and most of that was very deteriorated. One or two very dry planks, plus a quantity of roundwood were encountered, but were too decayed for

detailed analysis. One large piece of oak timber debris was in good condition. This item is a tangentially split baulk of timber taken from a felled tree with a towing mortice near the felled end. This supports the suggestion that much of the wood, that is the planks and roundwood, had lain around for some time before being buried, whereas the oak timber debris is in better condition and may have floated across from the platform.

Beavers in the Fens

The European beaver (*Castor fiber*) was common in some parts of Britain until medieval times. Beaver bones have been found in various contexts dating from the post-glacial period onwards, and a short note, written over a hundred years ago, is still probably the best summary of what we know about this enigmatic creature (Miller and Skertchly 1878, 348):

> The remains of the beaver are tolerably abundant in the Fens. The animal became extinct in England in the 12th and 13th century, but it still survives in the Rhone and in the rivers of Lithuania and Scandinavia. So far as my observation goes the beaver did not build dams in the Fens, owing, in all probability, to the abundance of still water. The late J. K. Lord, himself an experienced trapper, informed me that in North America the beaver only constructs dams in running streams, and chooses still water where possible to save the trouble of architecture.

European beavers are very similar in their habits, as well as in their preferred habitats, to Canadian beavers (*Castor canadensis*). They do not necessarily build dams and lodges and it is recorded that, in some areas in Europe, beavers live in burrows in the banks of slow-moving rivers (Corbet and Ovenden 1980, 149–50). In beaver ecology the most important factors are the presence of both slow-moving water and broad-leaved trees, which provide their staple food. The environment of the Fengate/Northey embayment would have presented a suitable habitat that would have supported many of the beavers' favoured tree species, especially poplar, willow and alder.

Discussion

Most of the wood encountered during the Visitor Centre excavations came from approximately the same levels as the research excavations of Area 6 on the platform and post alignment. This, taken with the discovery of a single piece of timber of probable Bronze Age date, suggests that the pier or trackway was broadly contemporary with the post alignment, towards which it might originally have been heading, if indeed it was man-made. At this point it should be noted that a recent publication has drawn attention to the difficulties of distinguishing a beaver dam from a trackway or similar structure (Coles 2006, Fig. 3.9).

The quality of the wood was not good and much of it was dried out and decayed. This means that the amount and quality of the data was limited, although this was counterbalanced by the fact that this data came from areas of the site which had not previously been well studied.

When the small assemblage of 'beavered' wood from the platform at Flag Fen was first discussed (Taylor 2001, 202–3), it was suggested that the relatively small diameter of the wood from the platform implied it was used for food rather than construction of dams or lodges. Beavers cut down and chew much more wood than they can actually eat. Some wood is dragged under water to store for winter, but quantities of wood debris also lie around in areas 'grazed' by beavers. It was further noted that beavered wood occurred low down in the platform make-up, suggesting that the beavers were active in the vicinity before construction began, possibly being driven away by the onset of human activity.

Once alder was being systematically coppiced in the area to produce poles, the attention of beavers would have been unwelcome; Coles has pointed out that the activities of beavers in building lodges and dams may extensively affect water levels and other aspects of the local environment (Coles and Orme 1982, 67–72). It is interesting to note, however, that there is 'beavered' wood in the lower levels of the post alignments at Fiskerton (Taylor in prep.) as well as at Flag Fen. It may be that the post alignments subtly altered the local environment, in fact making conditions more attractive to beaver.

The wood in the moat was not in good condition, except the timber off-cut. Indeed, most of it had obviously been lying about in antiquity – the consequence of a known beaver habit. One is left with the general impression that the fen-edge, which was well away from the platform on this side, was congested with alder carr and was frequently visited by both people and beavers.

The post alignment at the Northey landfall

During excavations associated with the Northey landfall Project (Chapter 3, this volume), part of the eastern extent of the post alignment was excavated. Within the adjacent and overlapping areas trenches NT2 and 2003/2 a 14m×10m expanse of the structure was revealed (Fig. 3.18). These excavations on the terrace gravels along the edge of the high ground of Northey 'island' investigated a much drier environment than the waterlogged peat of the embayment proper. Therefore, although the structure is clearly defined by post-holes in the gravel, little wood survived. However, despite the dry deposits some wood survived in twenty-six of the alignment post-holes.

The vast majority of the surviving wood was oak, which seems to indicate that less robust species, such as willow and poplar, had already decayed away. For the most part, only the deepest and broadest post-holes still contained wood. The wood was generally in poor condition with deep radial drying cracks. Many pieces showed evidence for distortion and severe radial shrinkage resulting from desiccation. In many cases, the wood had shrunk so much within the post-hole that a void was left, allowing the timber to be extracted with relative ease.

Category	Frequency	%
artefact	1	0.56
roundwood	29	16.38
timber	83	46.89
timber debris	22	12.44
debris	40	22.60
unclassified	2	1.13
Total	177	100

Figure 4.19. Principal categories of wood and timber from the V Series

Condition Score	Frequency	%
not scored	56	31.64
1	0	0.00
2	5	2.82
3	101	57.06
4	15	8.48
5	0	0.00
Total	177	100

Figure 4.20. Condition score of the V Series

The pieces of wood that were extracted bore a marked similarity to the lower worked points of posts elsewhere along the alignment. Where woodworking was still visible, they appeared to have been sharpened using the method seen before, with the lower tip worked from all directions into a tapered point. This suggests that they would have been driven rather than dug in (in which case their bases would more likely have been flat). Although radial shrinkage precluded detailed analysis of the split types present, there was, as would be expected, clear evidence for timbers in the round as well as for radial and tangential splits.

It is greatly reassuring to find timbers at the furthest excavated point to the east of the alignment that are similar in size, species and woodworking technique to those excavated at other points along the alignment. Although the wood had degraded to such an extent that detailed recording was not possible, the similarity between these and other posts of the alignment was clear to see.

Woodwork from the 'watering hole' F292 in Trench 2003/1

Remains of a wattle revetment aligned east–west across F292 survived to a maximum height of 0.35m for a length of 1.30m from the eastern trench side (Fig. 3.30). The *in situ* wattlework consisted of six vertical stakes, or sails, which were tied together by interwoven horizontal rods. The six stakes were straight rods typical of coppiced material; their bark was intact and each had an axed end trimmed to length from either one or two directions. The diameter of the stakes ranged from 35mm to 52mm. This range of diameters closely matches that recorded for the Late Bronze Age hurdles of the Eclipse track in Somerset (Coles *et al.* 1975). The length of the stakes ranged between 110mm and 470mm; all had rotted off and would originally have survived to a greater height.

The horizontal rods, or weavers, varied between 10mm and 30mm in diameter and had a maximum length of 680mm. The surviving fragments were woven in a simple under/over pattern and did not seem to have been aligned to accommodate different thicknesses, as is still usual in hurdle manufacture (where proximal and distal ends alternate). The length and quality of the weavers suggests that they were probably coppice products.

Wood from the excavations of 2005

Introduction

The principal aim of the 2005 investigations was to assess the level of preservation of the wooden structures forming the western extent of the post alignment. A total of 177 items of wood was recorded in detail from the 2005 excavations. The wood assemblage recovered during the 2005 excavations has been assigned to the 'V Series'. Material was selected for detailed recording using the sampling strategy devised for the B Series.

The wood was recovered from four trenches spread across the western portion of the post alignment between the platform and the fen-edge. The assemblage is compared against material recovered from the Area 6 and Power Station excavations.

By class, timber is the most numerous category (Fig. 4.19). This is unusual for prehistoric wood assemblages, which are normally dominated by roundwood and debris (Taylor 1998; Bamforth 2006). The prevalence of timber within the assemblage is accounted for by the many alignment posts, set against the relatively low occurrence of associated horizontal material. This pattern contrasts with the B Series of the platform and post alignment, where timber accounted for just 8.55% of the total. The B Series also had higher proportions of roundwood (35.81%) and debris (31.01%) than the V Series.

Preservation of material

The majority of the material recovered from the 2005 excavations scores 3 (moderate) on the condition scale used in this report (Fig. 4.20). This score suggests that preservation is on the borderline for meaningful analysis; at this level of degradation it becomes difficult to quantify the type and nature of woodworking. The loss of surface definition also means that it is difficult to accurately define tool facets and split surfaces.

Discussion of the wood from the 2005 excavations

The height of the upper preservation horizon in both the Area 6 and 2005 excavations was very similar, which might suggest that preservation in the two areas was also

equivalent. However, wood from Area 6 was far better preserved. Our analysis suggests that the burial environment that has protected the Flag Fen organic deposits is changing, causing degradation that will ultimately lead to a lowering of the preservation horizon. The artificial lake seems to be mitigating these changes, although the character and extent of this protection remains to be quantified (see Chapter 2, this volume). As noted above, the majority of wood recorded during the 2005 excavations was on the borderline in terms of its condition for the recording of woodworking technology, and any decrease in its condition may result in a serious drop in the data retrieval possible for material remaining *in situ*.

There is tentative evidence to suggest that wooden structures suffered more disturbance in antiquity as the distance increased from the fen-edge. This may be associated with greater energy levels in the fluvial system further into the basin. It appears that taphonomic factors such as these have led to sample bias in which smaller material, such as roundwood and debris, are under-represented. It is also possible that the structures themselves create unique conditions. It is probable that the platform would have protected timbers from any flushing effect – a protection that would not be afforded to the horizontal timbers of the post alignment away from the platform. Even taking these processes into account, roundwood still seems to be under-represented and there is no obvious reason for this, although the relatively small size of the sample could be a factor.

The woodworking technology and species selection of the alignment posts in both Area 6 and 2005 are very similar. This suggests that the construction and maintenance of the post alignment on the platform and in the open fen was the responsibility of a single group or authority.

The B Series and the 2005 assemblages compared

Although the six fold condition scale (Fig. 1.1) was not used during recording of the A and B Series, material from Area 6 is generally accepted to have scored a 4 or a 5 (good or excellent) when first exposed. The good level of preservation can clearly be seen in photographs of the excavations and the photographs and illustrations of artefacts recovered from the area. Indeed, it is the degree of preservation seen in Area 6 that allowed such detailed analyses of woodworking and tool use to be carried out.

Tool marks as a proxy indicator of preservation

The disparity in preservation between the 2005 assemblage and the B Series is clearly illustrated by the toolmarks recorded from the two assemblages. Only two were recorded from the V Series, which represents some 1.13% of the total assemblage. By comparison, 6.06% of the B Series wood displayed recordable marks. As no variation in tool use or woodworking practices was noted between the two areas the lack of toolmarks from 2005 is most simply explained by post-depositional degradation.

The role of relative spatial position in determining degree of preservation

A direct relationship between height above or below OD and preservation has often been noted in waterlogged assemblages, both at Flag Fen and elsewhere (Holden *et al.* 2006). The general rule is that preservation improves as height above OD decreases. When preservation was plotted spatially, it was impossible to distinguish any clear-cut trends along the post alignment in the area of the 2005 excavations, although, as predicted, preservation did improve with depth.

As both the V Series and B Series assemblages were recovered from very similar depths, it seems most improbable that this would explain the observed difference in preservation. The highest surviving piece of waterlogged wood from the 2005 excavations was at 1.21m OD, with wood consistently present below 1.10m OD. This compares well to the B Series (Area 6), where the highest single item was at 1.25m OD and wood occurred consistently below 1.10m OD (Fig. 4.21).

The figures just given suggest a broadly uniform preservation horizon exists for waterlogged wood across the Flag Fen basin. Although the preservation horizon does not vary significantly in terms of height between the two areas of excavation, the condition of the material immediately below that horizon is significantly more decayed to the west of the platform than within the platform itself. The difference in wood condition below the broadly uniform preservation horizon suggests that until relatively recently, the factors that determined preservation across the site were similar and that the observed differences between Area 6 and 2005 are most probably the result of recent changes to the burial environment.

If a change in the burial environment is responsible for the poorer preservation seen in the 2005 assemblage, it may be that the wood in Area 6 was (and is) being protected from these changes by its proximity to the artificial lake, or mere, which is known to leak because it was impossible to seal the different polythene sheets of the enclosing membrane together. They were overlapped by a couple of metres or so, but were not secured, as to do so would have given the 3m-deep trench time to collapse (Pryor 2001, 11–14). If the lake is indeed leaking, then proximity to it could now be a major factor in determining the quality of wood survival outside it. Other factors affecting wood preservation have been discussed in Chapter 1.

Taphonomy and site formation processes

Analysis of wood from the Power Station site suggested a high degree of sample bias caused by decay. These post-depositional factors caused debris found there to be under-estimated. As we have seen, the 2005 assemblage revealed a tiny proportion of debris and far less roundwood than would normally be expected. The prevalence of timber debris (or off-cuts) in the A and B Series suggested that woodworking

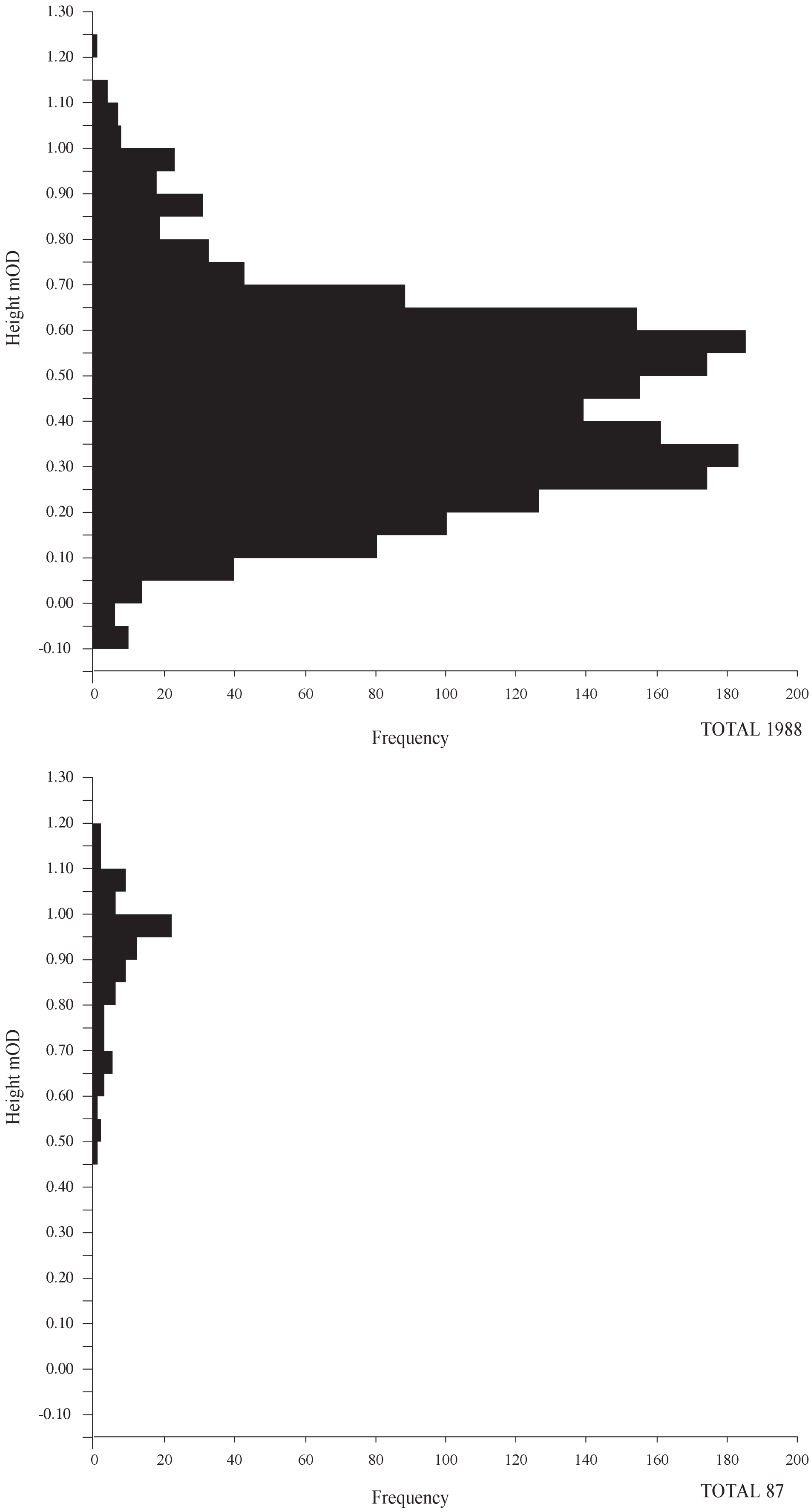


Figure 4.21. Height AOD of wood from the B Series (1) and V Series excavations (in m)

was taking place along the post alignment, and if this were the case then smaller debris associated with woodworking would be expected to form a far larger proportion of the 2005 assemblage.

The presence of small diameter roundwood (<20mm) within the 2005 assemblage suggests a moderate level of preservation that would preclude post-depositional degradation as a major sample bias. Small diameter roundwood is formed of soft, sappy wood. If this material survives, then larger diameter more mature roundwood and debris, often formed from the rot-resistant heartwood of more mature trees, would also be expected to survive (Rowell and Barbour 1990). In contrast, it was noted that wood from the Power Station site had suffered a high level of sapwood degradation indicative of post-depositional decay.

Analysis of the Power Station material concluded that the more dynamic environment of the fen, away from the protection of the platform, would lead to a higher degree of taphonomic bias. The fluctuating water levels and flowing water in the environment of the 2005 and Power Station excavations could be expected to wash away a greater proportion of smaller debris than larger timber, introducing a bias into the sample. This is particularly relevant when it is borne in mind that non-waterlogged wood floats.

This suggestion is supported by the lack of debris and the lack of bark attached to wood from the 2005 assemblage. Normally, roundwood can be expected to have some bark remaining. Similarly, some of the debris and timber with the outer surface of sapwood intact could also be expected to retain some bark intact. If, as suggested above, the post alignment in this area was in a dynamic wetland environment, the lack of bark may well be post-depositional, the bark being knocked off or abraded when wood was moved or jostled by fluctuating currents.

As the sampling strategies employed at the Power Station (A Series strategy) and the 2005 excavations (B Series sampling strategy) were different, a direct like-for-like comparison is impossible. It does seem clear, however, that sample bias was more pronounced in the 2005 excavations than at the Power Station – and this despite the fact that the Power Station assemblage had suffered greater post-depositional degradation.

As degradation has been ruled out as a major cause of sample bias in the 2005 assemblage, the presence of large timber debris strongly suggests that much greater quantities of smaller debris ought to be present. It would seem that this distortion was probably the result of taphonomic processes, such as the effects of the dynamic wetland environment. As these effects appear to have been more pronounced out in the basin this would explain why the 2005 assemblage was more affected than that of the Power Station site; it would also explain the under-representation of roundwood in 2005.

Three items from the 2005 investigations (V0091, V0131 and V0132) displayed the grooves and damaged surface characteristics of fungal decay in antiquity, often refferred to as 'wet rot'(Coggins 1980; Eaton and Hale 1993). In all three cases evidence of extensive wet rot was recorded on the upper surface. Where the deterioration can be seen to have occurred in antiquity it can be used as an indicator of exposure to the elements prior to burial and subsequent preservation. So the presence of wet rot could be seen to indicate a surface, possibly representing a use horizon such as a footpath or walkway. This is particularly interesting in the case of V0131 and V0132, both of which lay adjacent to each other and at the same level.

Roundwood compaction

Prehistoric waterlogged wood assemblages are prone to post-depositional compaction caused by compression of the surrounding matrix as it dries out (Taylor 1998). This is most apparent in roundwood, being formed of less mature and less robust cells than the heartwood of trunks and major boughs. If we assume that most roundwood was originally circular in section at the point of deposition, then an oval cross section can be used to quantify the degree of compaction that has occurred.

By measuring the long and short axis of compacted roundwood the two figures can be expressed as a ratio and the degree of compaction within the roundwood element of an assemblage can be quantified. A compaction ratio of 1 describes an uncompacted piece of roundwood.

A greater proportion of the V Series than the B Series roundwood had been subjected to compaction. When histograms of the two Series are compared, both peak between 1.15 and 1.30. The most compacted items from the V Series have a compaction ratio falling between 1.55 and 1.60. By contrast, 7.74% of the B Series roundwood had a compaction ratio greater than 1.60 (Fig. 4.22 and 4.23). So, although compaction was more prevalent in the V Series, more extremely compacted items were to be found in the B Series. At present, the causes of this disparity are not clearly understood.

Timber

Upright posts

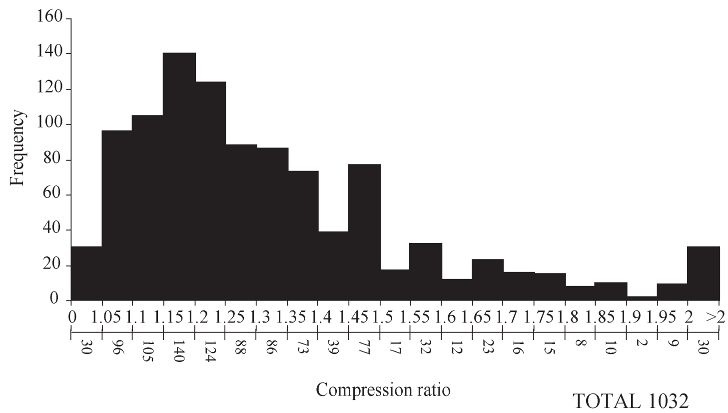
Of the 83 items from the V Series categorised as timber, 61 were posts and a further 22 lay horizontally. All the posts were probably part of the post alignment. Seven were fully excavated; all had been trimmed to the tapering point typically found on uprights of the alignment and driven into the underlying Pleistocene clay-capped gravels. Two (V0017 and V0043) showed some compression damage to the tip; this probably happened in antiquity, as the post was being driven into the ground. Oak is the commonest (78.69%) species for uprights; alder and birch are also represented. The predominance of oak among the V Series uprights when compared to those of the A and B Series probably reflects the fact that the 2005 excavations did not encounter the predominantly alder Row 1 (Pryor 2001).

Although most posts were only partially revealed, it was still possible to record their method of conversion. The distribution of unconverted roundwood posts and splits was very similar in the Area 6 and 2005 excavations (Fig. 4.24). In both cases, roundwood posts dominate the

	B series								
	1	*1.05*	*1.1*	*1.15*	*1.2*	*1.25*	*1.3*	*1.35*	*1.4*
Frequency	462	30	96	105	140	124	88	86	73
%	30.92	2.01	6.43	7.03	9.37	8.3	5.9	5.76	4.89
	V series								
	1	*1.05*	*1.1*	*1.15*	*1.2*	*1.25*	*1.3*	*1.35*	*1.4*
Frequency	5	0	1	6	3	7	2	1	2
%	17.24	0	3.45	20.68	10.34	24.14	6.9	3.45	6.9
	B series								
	1.45	*1.5*	*1.55*	*1.6*	*1.65*	*1.7*	*1.75*	*1.8*	*1.85*
Frequency	39	77	17	32	12	23	16	15	8
%	2.61	5.14	1.14	2.14	0.8	1.54	1.07	1.01	0.53
	V series								
	1.45	*1.5*	*1.55*	*1.6*	*1.65*	*1.7*	*1.75*	*1.8*	*1.85*
Frequency	0	1	0	1	0	0	0	0	0
%	0	3.45	0	3.45	0	0	0	0	0

Figure 4.22. Flag Fen B Series and V Series compression ratios

1



2

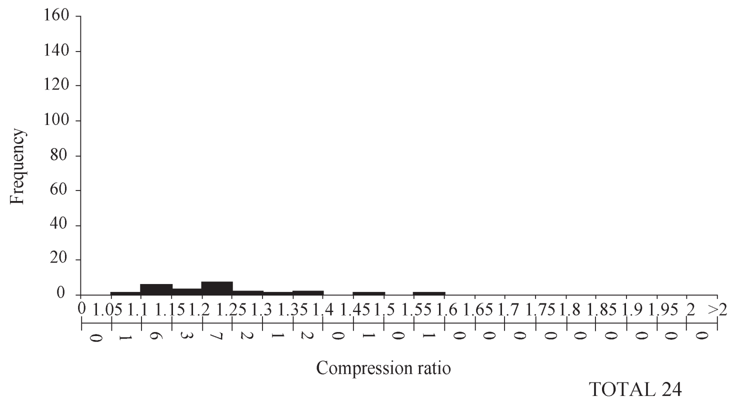


Figure 4.23. Flag Fen B Series (1) and V Series (2) roundwood compression ratios

Category	*B Series*	*V Series*
roundwood	61.9	65
radial	27.1	28.33
tangential	10.3	6.67
unclassified	0.7	0
Total	100	100

Figure 4.24. Conversions of V Series upright posts recovered during 2005 excavations

	Length							
	0-200	*200-400*	*400-600*	*600-800*	*800-1000*	*1000-1200*	*1200-1400*	*1400-1600*
Frequency	14	6	3	3	1	0	1	0
%	48.28	20.69	10.34	10.34	3.45	0	3.45	0

	Diameter							
	0-20	*20-40*	*40-60*	*60-80*	*80-100*	*100-120*	*120-140*	*140-160*
Frequency	5	10	6	0	3	1	1	2
%	17.24	34.48	20.69	0	10.34	3.45	3.45	6.9

	Length							
	1400-1600	*1600-1800*	*1800-2000*	*2000-2200*	*2200-2400*	*2400-2600*	*2600-2800*	*total*
Frequency	0	0	0	0	0	0	1	29
%	0	0	0	0	0	0	3.45	100

	Diameter		
	140-160	*160-180*	*total*
Frequency	2	1	29
%	6.9	3.45	100

Figure 4.25. V Series, roundwood dimensions (in mm)

assemblage, with radially split posts second in frequency and tangential splits the least abundant. Not only is the order of reduction the same in both excavations, but the percentages of categories are also similar.

Horizontal timber

A total of 22 horizontal timbers were recorded from the V Series. Oak was again predominant (20 examples). All timbers had been split: 13 (59%) radially and 9 (41%) tangentially. There was a relatively high prevalence of jointed timbers among the horizontal pieces, a full catalogue of which is provided below.

Jointed items – catalogue

V0015: wood species: oak (*Quercus* sp.); conversion: tangential; joints: broken mortise (270×100×81mm); dimensions: length 1230mm, width 140–160mm, thickness 72–81mm; context: F.

V0016: wood species: oak (*Quercus* sp.); conversion: radial; joints: slot (210×60×60mm), broken mortise 170×60mm); dimensions: length 2040mm, width 250–290mm, thickness 60mm; context: 2005/4.

V0052: wood species: oak (*Quercus* sp.); conversion: radial, one end displays a possible felling scar; joints: blind mortise (95×56×29mm); dimensions: length 680mm, width 60–130mm, thickness 70–90mm; context: 2005/1 (0.68m OD).

V0056: wood species: oak (*Quercus* sp.); conversion: radial; joints: housing lap (85×30mm); dimensions: length 1335mm, width 115–124mm, thickness 15–44mm; context: 2005/1 (0.78m OD).

V0087: wood species: oak (*Quercus* sp.); conversion: radial; joints: lap (745×42×40mm); dimensions: length 915mm, width 33–104mm, thickness 20–65mm; context: 2005/4 (0.85m OD).

Both the style of splitting and the form of the joints are typical of Bronze Age woodworking at Flag Fen. The joints all have direct parallels within the A Series (Taylor 2001). The worked timber from FF05 is markedly similar in terms of form, size and style to that from the platform and alignment excavations of the A and B Series.

Roundwood

In total, 29 (16.38%) pieces of roundwood were recovered as part of the V Series assemblage. This may be compared with the A and B Series, in which roundwood comprised 56.32% and 35.81% respectively. The closest comparison is with the B Series, which was recovered with the same sampling strategy as the V Series. Diameters ranged from 15mm to 190mm, with a mean of 51.24mm, while lengths varied from 69mm to 2720mm, with a mean length of 408.53mm. Nine items had been trimmed at one end, while only three items displayed clear evidence for coppicing. A single toolmark (37:5mm) was recovered from V0136. Despite the small sample size, measurements of the V Series roundwood have been provided for the record (Fig. 4.25 and 4.26).

After analysis of the A Series it was concluded that roundwood as a category, whether worked or unworked (although excluding natural roundwood) was in itself a 'finished product' brought to Flag Fen to be used as make-up and support for the platform and for the walkways that ran between the five post rows. The majority (80.57%) of the Flag Fen A Series roundwood assemblage was larger than 20mm, suggesting that the majority of the roundwood items were poles and larger pieces suitable for use as structural timbers. Similarly, the positioning in the ground of the sub-20mm roundwood, which could have been woven into wattle, indicates that little, if indeed any, had actually been used for that purpose.

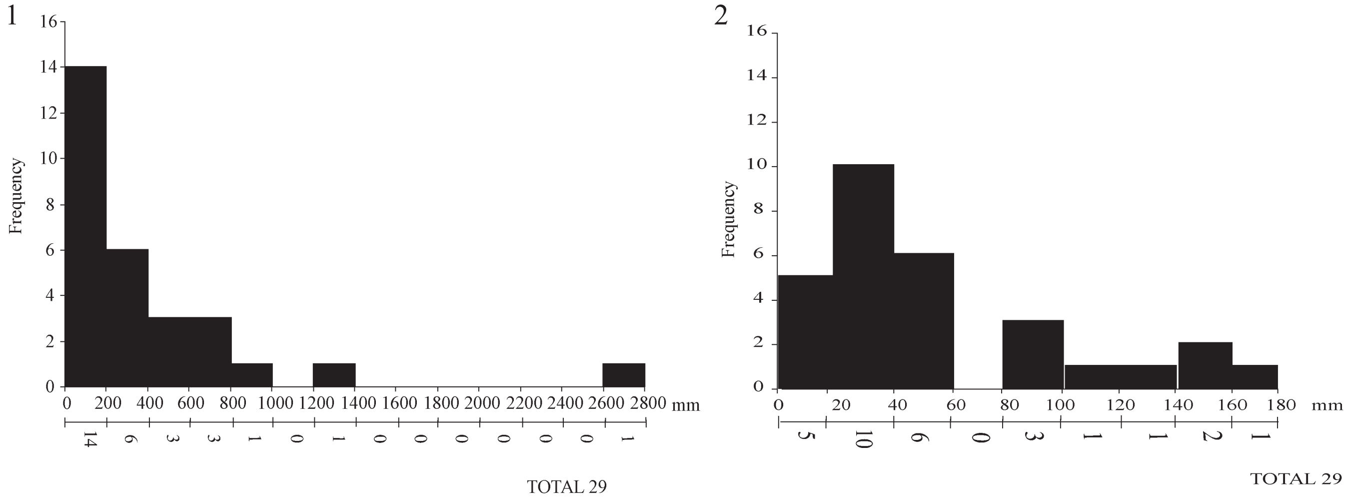


Figure 4.26. Flag Fen, V Series roundwood lengths (1) and original diameters (2). Measurements in mm

While the 2005 trenches were located outside the limits of the platform and thus the presence of large quantities of roundwood as a make-up layer was not expected, the positioning of the trenches across the post alignment would suggest that roundwood should have been present in large amounts to form the walkways and wattle revetments associated with it elsewhere. Roundwood was, however, uncharacteristically rare within the 2005 assemblage, especially when compared with the B Series. We have seen that this was probably due in part to site formation processes – especially the local fenland environment – which seem to have removed a significant quantity of small-diameter roundwood. However, this lack of roundwood seems too pronounced to be a result of post-depositional processes alone and may well reflect the small size of the sample excavated.

General discussion and conclusions

Although the fire of 2000 has seriously inhibited any spatial analysis of the B Series wood, a brief analysis of the assemblage has still been possible. The survival of previously published plans of the upright posts of the alignment has allowed a detailed analysis of the woodworking technology of the alignment and the types of tool used in its construction.

The vast scale of the Flag Fen wood assemblage and the broad time frame over which the project has been conducted has not only informed the analysis of the Flag Fen wood assemblage but also allowed many important lessons to be learned about the recording and analysis of prehistoric worked wood. Certainly, the sheer volume of data produced by a large assemblage has shown that information retrieval is not the problem; when faced with such a vast potential pool of data, the dilemmas are more to do with what *not* to record. Clear and definable research objectives proved essential from the outset; without these, the construction of a workable sampling strategy would have been impossible, as would the definition of general areas of data collection. Techniques of recording, categorisation and analysis developed by Taylor (1998 and 2001) have proved to be both robust and appropriate at Flag Fen and when applied to other prehistoric assemblages.

During the course of the woodworking analyses the recording of data was continually refined. It was realised that graphic representations of toolmarks were not, strictly speaking, necessary, and that recording the width and depth of a toolmark was sufficient for current analyses. However, graphic depictions of complete examples can prove informative and they form an important component of the archive that may well be of considerable use to future scholars.

As work continued it became clear that simplification was both possible and desirable. For example, in the case of axed and trimmed ends it was usually possible to decide subjectively whether the working in question represented felling (usually indicated by the characteristic 'duck billed' felling scar and hinge), trimming to length or sharpening to a point. This was then recorded. Next, and in all cases, an objective record of the number of directions from which an item had been worked was made. For example, a piece could have been trimmed to length from two directions (appearing much like the point of a chisel), or perhaps worked to a tapering point from all directions (like the end of a sharpened pencil).

It was found, however, that measuring the length of working of a sharpened end (*e.g.*, the length of the 'pencil point') was not fruitful. Although nearly all the posts of the alignment were trimmed to a tapering point from all directions, simply to make them easier to pile-drive (and similar all-round pencil-like sharpening is seen on driven piles recovered from a wide variety of prehistoric

contexts (Taylor 1998; Bamforth 2006)), and the length of the sharpening does vary, this does not seem to have chronological, functional or indeed cultural significance. In other words, no patterns could be detected which suggested that the variation reflected personal working style or preference.

Although the bulk of the evidence supports the use of a very specific axe size and type in construction and maintenance at Flag Fen, a wide variety of tool facet sizes has been noted. It would seem, therefore, that personal working style was a major factor determining tool facet size. Although maximum facet size may thus be used as a proxy indicator of tool size, it soon became clear that there was little point in systematically recording facet size when evidence for complete toolmarks was so plentiful.

Measurements have been a particularly accessible and useful data set. For example, the diameters of roundwood, where coppicing is suggested by other, morphological, traits, can be compared with both modern and ancient coppice products. Similarly, the maximum and minimum diameters of small roundwood can be used to assess the degree of compaction.

Recording the original diameter (where possible) of converted timber has been particularly informative and has given insights into the selection of raw material for conversion into timber. Original diameter can be recorded only where the bark edge and pith are both present, but experience has shown that, in future, it may also be advisable to record a 'minimum possible original diameter'. Hopefully this would give a fuller understanding of the size of material selected for conversion.

The vast scale of wood data has clearly demonstrated that computerised databases are essential. From the earlier days of Maxarc (Booth *et al.* 1984), through several Access databases, they have proved invaluable. Indeed, their usefulness will grow as other wood databases become available in the future, and part of the work involved in the production of this monograph has been to provide a reconstructed post-fire database that will soon, it is hoped, be made available online. Having successfully compared the large Neolithic assemblage at Etton with that at Flag Fen, the next logical step is to compare these with a similarly large Iron Age assemblage, should one become available.

Some notes on surviving hafts and handles

By Maisie Taylor

Axe haft B5000

In the latter stages of excavation at Flag Fen (Area 6D), the head of a socketed axe haft made of oak (*Quercus* sp.) was revealed (length 85mm; thickness 50/30mm). The haft head, which was broken just below the head, shearing along the medullary rays, still bears the impression of the axe on the foreshaft. This break is likely to have been caused by the bending of the head from side to side, possibly by standing on the head and pulling on the handle. A haft is made to take impact and wear, but not to be used as a lever, and particularly not sideways. It seems likely that the haft was broken intentionally (Fig. 4.27).

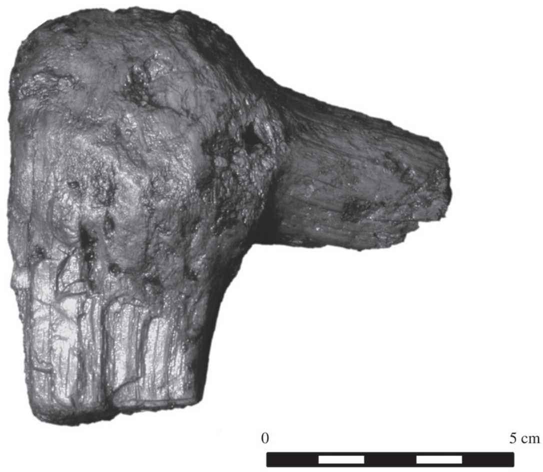


Figure 4.27. Artefact B5000, partial axe haft

This item would have been carved from a single piece of a small tree. The handle would have been carved down to a dowel from a small tree trunk with the foreshaft formed from a modified side branch approximately 30mm in diameter

This haft brings the total number of axe hafts from Flag Fen to four, all of which are quite different, although the method of construction here is not dissimilar to the socketed axe haft Y930 from Flag Fen (Taylor 2001, 220). It is very similar in construction to the palstave haft excavated at Langtoft (Webley 2004), although, of course, the slot for the palstave is missing. This haft came from a feature which was dated to 1900–1510 cal BC. The similarity of a socketed axe haft to a palstave haft may indicate that it is an early form, but a series of experiments with replica axe hafts in 2004/5 suggested that different hafts may have fulfilled different functions. This would have made the axes much more versatile. Some modern tools have a universal haft or handle with different heads which snap on and off. The Bronze Age equivalent was a universal head (the socketed axe) with a variety of hafts for different functions.

The flesh-hook hafts from Flag Fen

Excavations in 2003 along the Northey fen-edge revealed a copper-alloy flesh-hook terminal (Finds No. 33), which is discussed here by Dot Boughton (Chapter 8). The haft is an ash dowel 14mm in diameter which shows three growth rings. Growth rings of this width (4–5mm) indicate a tree which is reasonably fast grown, but are far narrower than the sort of growth rings seen on ash coppice. The dowel is slightly smaller than the socket, which is 14.89mm in diameter, and was easily removed. This was almost certainly because it had begun to dry out (Fig. 4.28).

The haft has sheared just inside the socket along the

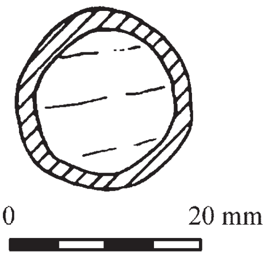


Figure 4.28. Fragment of wooden shaft in the handle of the flesh-hook (see Figure 8.14)

medullary rays. This kind of break is likely to have come about because of extreme sideways pressure. Unless there was a fault in the wood of the haft, an ash dowel would make a very strong handle, well suited for impact but with a certain amount of flexibility. All the wood in spear heads and ferrules from Flag Fen has been similar to this, with rivets, when they occur, at right-angles to the growth rings. Despite the rivet holes in the flesh-hook haft, there is no evidence for a rivet having passed through the wood.

The earlier flesh-hook handle from Flag Fen was made of roundwood (Taylor 2001, 225, Fig. 7.62, no. 6). It is bigger (20mm in diameter), and at the time it was felt that the use of shaped roundwood rather than a dowel might hint at the way that the flesh-hook was used. The roundwood haft would have been quite effective when used for pushing or pulling, but not for any sideways pressure. For this, a less flexible dowel handle would have been better.

Information about the wooden shafts of flesh-hooks is very sparse. A flesh-hook from the fen at Feltwell in Norfolk was reported as having fragments of wood in the socket but no further information was available for the original publication (Norfolk Museums Service 1977). A recent paper, however, has presented a considerable amount of new material about flesh-hooks and their shafts (Bowman and Needham 2007). The paper deals with complex hafts, particularly from Dunaverney, County Antrim and Little Thetford in Cambridgeshire. Rather than being one long 'handle', the Dunaverney flesh-hook shaft is composed of two lengths. The wood, which was oak, was inlaid with bronze and joined sections of the flesh-hook together. Needham suggests that the shaft, which is 16mm in diameter, may have been rebated to fit smoothly into the sockets.

Discussing the radiocarbon dating of the shaft in the 1990s, Needham comments that the date is probably very accurate because a shaft 16mm in diameter is unlikely to have come from 'old wood'. This raises an interesting point because there is little or no evidence for the diameter of material used to generate raw material for carving dowels, and indeed, it may have varied. The ash dowels associated with the flesh-hook discussed here, as well as the spearheads and ferrules at Flag Fen, show very little curvature on the growth rings, although, obviously, with such small sections it is hard to be quite sure (Taylor 2001, 225, Fig. 7.62, nos 1–4). One of the reasons for making these shafts from a dowel instead of roundwood is the minimising of the risk of splitting. A dowel taken from too near the pith of a log may be affected by it and one taken from too near the outside of the log may be affected by the tendency of the more sappy outer wood to split radially. As wood ages in the tree it tends to harden and become less flexible, so that smallish, good-quality trees would be needed to get the flexibility, length and lack of flaws required for a straight, strong shaft. Where oak is used for a haft, as at Dunaverney, these problems are magnified, because oak heartwood is relatively hard and inflexible compared to other species, while the sapwood is very soft and liable to rot. It is likely, therefore, that the wood of the Dunaverney shaft is likely to be no more than twenty years older than the flesh-hook for which it was used. The disadvantages of using oak as a hafting wood are that it is very heavy compared with ash and is much more likely to split along the medullary rays.

The flesh-hook from Little Thetford also had remnants of a wooden shaft approximately 18mm in diameter found 'in the lower socket or ferrule with a wooden peg through it' (Bowman and Needham 2007, 63), but no further information is available.

The Feltwell flesh-hook shaft has recently been identified as hornbeam (*Carpinus betulus*). Hornbeam is a hard wood, difficult to carve, but it can be coppiced, thereby producing straight, even stems. Significantly, it is highly resistant to shearing (Corkhill 1979). Given that the most recent find from Flag Fen appears to have sheared at the socket, this is surely significant.

The simple flesh-hook from Flag Fen is hafted with roundwood, while the ferrule and, as far as has been recorded, the complex flesh-hooks are all hafted with dowels. This difference is not connected with the technology, because the manufacture of dowels made of ash, oak and other species was already well established for the hafting of spear heads. There could be a number of other reasons for the difference. It might be a sign that the complex and the simple flesh-hooks were used in different ways and were therefore hafted differently. The form of the handles might indicate various levels of importance; alternatively, the roundwood handle could have been seen as temporary, being used towards the end of the flesh-hook's life. It is also possible that the roundwood handle, because it weakened the physical strength of the flesh-hook, was also seen as diminishing its power prior to its ritual deposition.

5. Big Trees and Monumental Timbers

Maisie Taylor

Techniques of reduction

From Neolithic to modern times in Britain and north-western Europe oak has been the timber of choice for buildings and other structures. At the same time, splitting (or cleaving) has been the technique of choice for shaping planks, boards and larger baulks of timber. Oak is more fissile (able to be split) than any other species. Fissibility is related to the microscopic arrangement of the fibres and rays, and the structure of oak, especially the large medullary rays, makes it relatively easy to split cleanly and accurately (Wilson and White 1986, Fig. 75).

Most modern woodworkers see the tendency of oak to split as a disadvantage (Brough 1950, 108) and would regard splitting as inferior to sawing, which is not the case: it is an entirely different technique. Prehistoric saws are rare and most look ineffectual; early saws may have been useful for cutting slots and small modifications, but they would have ineffective, difficult to use and very hard work (Goodman 1976, 110–15). This makes it unlikely that they were ever used routinely, and certainly not for the large-scale reduction of timber. For the experienced worker, however, the technique of splitting oak is accurate, straightforward and effective. Gertrude Jekyll, who recorded watching an experienced woodman splitting and moving a large tree trunk using just an axe and an iron wedge, gives a description of the process which is a little romantic (her photograph shows a very noble and manly woodman) but actually very informative (Jekyll 1899, 219–22).

Saws

The need to use saws may have become pressing only when the quality of wood declined to such a level that splitting accurately became more difficult. The splitting of such poor timber is also wasteful, and produces uneven timbers of inferior quality. Luckily this change in the quality of the raw material coincided with the development of harder metal (iron) and, with it, saws of higher quality (Goodman 1976, 115). A few fragments of bronze saws are known, but it is with the study of iron saws from Glastonbury that detailed analysis can be carried out. Where the feature has been recorded, these saws all appear to have backward-facing teeth. This means they would have been pull-saws and would have been used like a modern pruning saw. The best-preserved one from Glastonbury has a complete handle (Bulleid and Gray 1917, plate LX) and is described as having its teeth 'turned from side to side'; in other words, the teeth are set like a modern saw, making this implement a transitional form between the simple serrated blade and the modern saw where the teeth are set so that they are effective on both the pull and the push (Fig. 5.1). Goodman quotes Pliny (Goodman 1976, 116) describing how saws had to be modified to cope with cutting green hardwoods: 'The green woods, with the exception of Robur [a kind of oak] and the box offer a more obstinate resistance, filling the intervals between the teeth with saw-dust, and making its edge uniform and inert; it is for this reason that the teeth are often made to project right and left in turn, a method by which the saw-dust is discharged (Nat. Hist., XVI, 83)'. This technology was obviously new enough when Pliny was writing for him to think that it needed explanation.

The Glastonbury saw is curved, with a curved handle, both of which are necessary where the saw can only be used on the pull. The knob at the very end of the handle also makes pulling, rather than pushing, simpler. Pull-saws are harder to use with any accuracy and are certainly not suitable for carpentry. The saw from Fiskerton is similar (Fell 2003, 70 288/A), except that the teeth of the simple serrated blade are not set, nor are they all facing backwards.

The search for an efficient saw was the search for a way to impose the will of the worker on the wood, forcing it into whatever shape or size was required. The craft of splitting timber developed over thousands of years and uses the weaknesses and strengths of the wood to shape it. It is the difference between force and persuasion.

Splitting

There are two main ways of splitting oak: radially and tangentially (Fig. 5.2). Both begin with the log being split in half. Indeed, the principle behind all splitting of timber is always to split each piece exactly in half. When a log is

Figure 5.1 . A modern pruning saw shown with an Iron Age example from Glastonbury Lake Village (St George Gray 1917: Vol 2 Plate LX I 53)

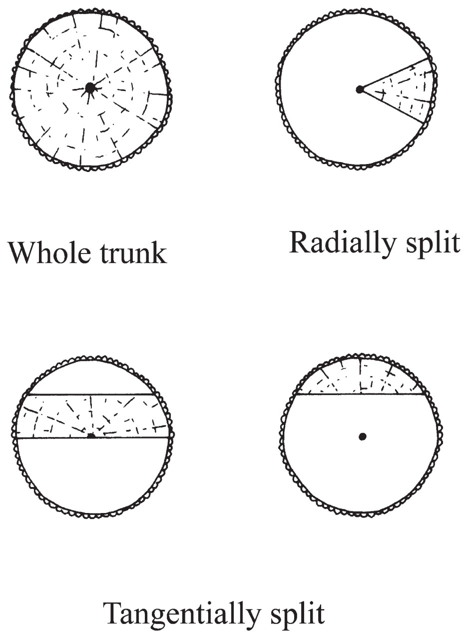


Figure 5.2. Splitting oak: radially and tangentially

to be split radially, it is split in half and then each half is split in half again, making quarters. The division is similar to dividing up a pie, with each section being cut in half. The quarters are halved again to make eighths, then sixteenths and so on. Thus a log approximately 300mm in diameter could be split in various ways depending on what was needed: half or quarter splits could make useful posts or beams, down to thirty-second splits, which will produce a stack of 32 feather-edge planks each about 150mm wide and with a thick edge of about 40mm. Virtually no wood is wasted with this method and this size tree. If the log to be split is a much larger trunk, however, the pieces produced are less obviously useful. The baulks of timber produced when a trunk 600mm in diameter is split into halves or quarters are too large for domestic use and need further reduction to bring them down to useful dimensions. If this further reduction is also radial splitting, however, the large boards produced become more and more wedge-shaped (Pryor 2005, Fig. 35). Hewing to square-up these boards is wasteful of wood, time and energy (Brunskill 1985, 30).

Before a log is to be split tangentially, it must first be inspected to ensure a good straight grain and the minimum of knots. Next it is split in half and then in half again, but tangentially. The second split is made across the grain, and parallel to the first split surface. The 300mm-diameter log split this way would produce two parallel-sided boards measuring 300×150mm and two boards with one flat face and one curved which would measure *c.*290×150mm (max). The two parallel-sided boards may be quite useful but the two lunate boards would be of limited use, especially as the whole of the curved surface would be sapwood and therefore very prone to rot. These boards are, in effect, wasted. Splitting tangentially is technically more demanding than splitting radially and it would be difficult, although not impossible, to split a 150mm-thick board tangentially in half to produce two boards 75mm thick.

To summarise: it is easier and less wasteful to split timbers with a diameter of approximately 400mm or less radially. Trees larger than this are relatively easily split tangentially and may produce large but useful boards. When we come to the very large trees, perhaps of diameters of 750mm and above, it is possible to split them either way but the timber generated will always be in large baulks. These timbers are unlikely to find a use in domestic structures. They will be difficult to handle and transport, while domestic structures built using them would be seriously over-constructed.

In 1988 the opportunity arose to learn at first hand about

the intricacies of splitting a large tree. The hurricane which caused so much damage to so many trees across southern Britain brought down a large oak tree in the woods of the Nature Reserve at Minsmere, Suffolk. Richard Darrah was kind enough to tell us about the availability of the tree, and brave enough to volunteer to teach/supervise us in the splitting of it. This tree, and others subsequently split at Flag Fen, enabled us to find out for ourselves the importance of the initial selection of the raw material. If a tree is to be split cleanly and accurately, it needs to be as straight-grained and as free from knots and blemishes as possible.

One of the important factors we discovered with guidance from Richard Darrah is the ease of working oak while green (Desch 1977, 115). The ability of seasoned oak to blunt even modern tools is well known (Brough 1950, 108). When a tree is felled it is 'green' and once felled it immediately begins to season. In the first instance, seasoning is the reduction of the moisture content of the wood. Freshly felled wood is also full of sap, sugars, tannin and other acids, as well as minerals, resins and so on. Exposure to the air gradually dries the wood until its moisture content is the same as the air that surrounds it. During this process the wood may distort and crack, but once seasoning is complete the wood will be much more stable, as well as being less prone to rot because its chemical constituents have become inert (Corkhill 1979, 494).

To split green oak, wooden wedges are required. Oak is used for these wedges, but they are fashioned while the wood is green and then allowed to season. This makes them far harder than the wood to be split. The process is started with small wedges which are as sharp as possible. As the wood cracks and the split begins to run, thicker and thicker wedges are used to push the two halves apart. The accuracy of the splitting is affected by the quality of the wood and the care taken in the preparation and placing of the wedges. Brute force is not an advantage; indeed, patience in letting the splits run without being forced produces much better results. (Much of the early experimental splitting at Flag Fen was done by Francis Pryor, Janet Neve and the author, under the supervision of Richard Darrah.) However careful and experienced the worker, knots and other blemishes can disrupt a split; and, as splitting follows the grain, a twisted tree cannot be split straight. Another feature of the splitting process was the sound made by the tree as it split. The sound of splintering wood is to be expected, but a big tree may 'groan' as it splits: it is a lifelike, almost heart-rending, noise and must have affected the attitude of prehistoric woodworkers to the trees they worked on. Finally, the tannic smell of the oak was very pungent after splitting, sometimes pricking the eyes and back of the throat. Again, this must have affected the way prehistoric people would have regarded great oaks.

The quality of the raw material

The raw material available to prehistoric woodworkers was often of a much finer quality than that available today. The size and quality of the ancient trees can be seen in some of the bog oaks which have eroded out of the Fens from time to time. Godwin suggests that bog oaks have not uncommonly been as long as 27m without a side branch (Godwin 1978, plate 14). To some extent, the large size of the trees which were available can also be deduced from dug-out boats (McGrail 1978, 119–20). Unlike most modern oak trees, which have grown in fairly open environments, prehistoric trees may often have grown in thick forest. These trees would have been drawn up over a long period as they grew, competing for light, air and water. This competion would have caused quite slow growth, narrow growth rings, dense wood and a lack of side branches, which would have tended to die back while still quite young and soft, leaving negligible knots and blemishes. At the opposite end of the spectrum would be an oak tree that has grown in a park. These trees are very beautiful and are most people's idea of an 'English Oak'. However, the timber from them is not particularly useful, nor is it of high quality. An oak tree growing in the open will develop side branches and may be nibbled by passing browsers; its wood will be twisted, knotty and gnarled.

Timber at Flag Fen

During the early stages of excavation at Flag Fen in the 1980s it was noticed that vertical posts fell into two clear categories. Most were roundwood, with or without bark, often alder, but occasionally other species too, including oak. It was suggested that these roundwood verticals, particularly the alder, may have represented the earlier phases of the post alignment (Pryor 2001, 157). A few verticals were noticeably larger and of worked oak. Whereas the roundwood was normally around 200mm in diameter, these oak verticals were obviously derived from much larger trees. Timber B379, for example, stood out as one of these timbers in the excavation and in photographs (Pryor 2001, Fig. 6.33). After the lifting it was seen that it was a half-split tree that was subsequently squared (Taylor 2001, Fig. 7.33). The timber, as it survived, is 1650mm long, but it was obviously originally longer. The width is 290mm and the thickness 130mm. Although the alignment of the splits makes it impossible to calculate the exact diameter of the original tree, the fact that there is no sign of sapwood or bark indicates that the original diameter must have been well over 300mm. The straight, even grain also suggests that it is one of the larger forest trees discussed above. Like many prehistoric timbers, Timber B379 has a mortice joint cut through it approximately 1m from the tip. It has long been suggested that some of these holes, which do not appear to have been suitable for any other practical purpose, were used for towing (*e.g.*, Coles and Orme 1978, 36). Recent finds in the area have finally confirmed that some holes at least were cut purely to secure ropes for towing (Garton *et al.* 2001; Brennand and Taylor 2003, 14 and 62).

When these large oak timbers occurred as horizontals, they contrasted even more dramatically with the roundwood

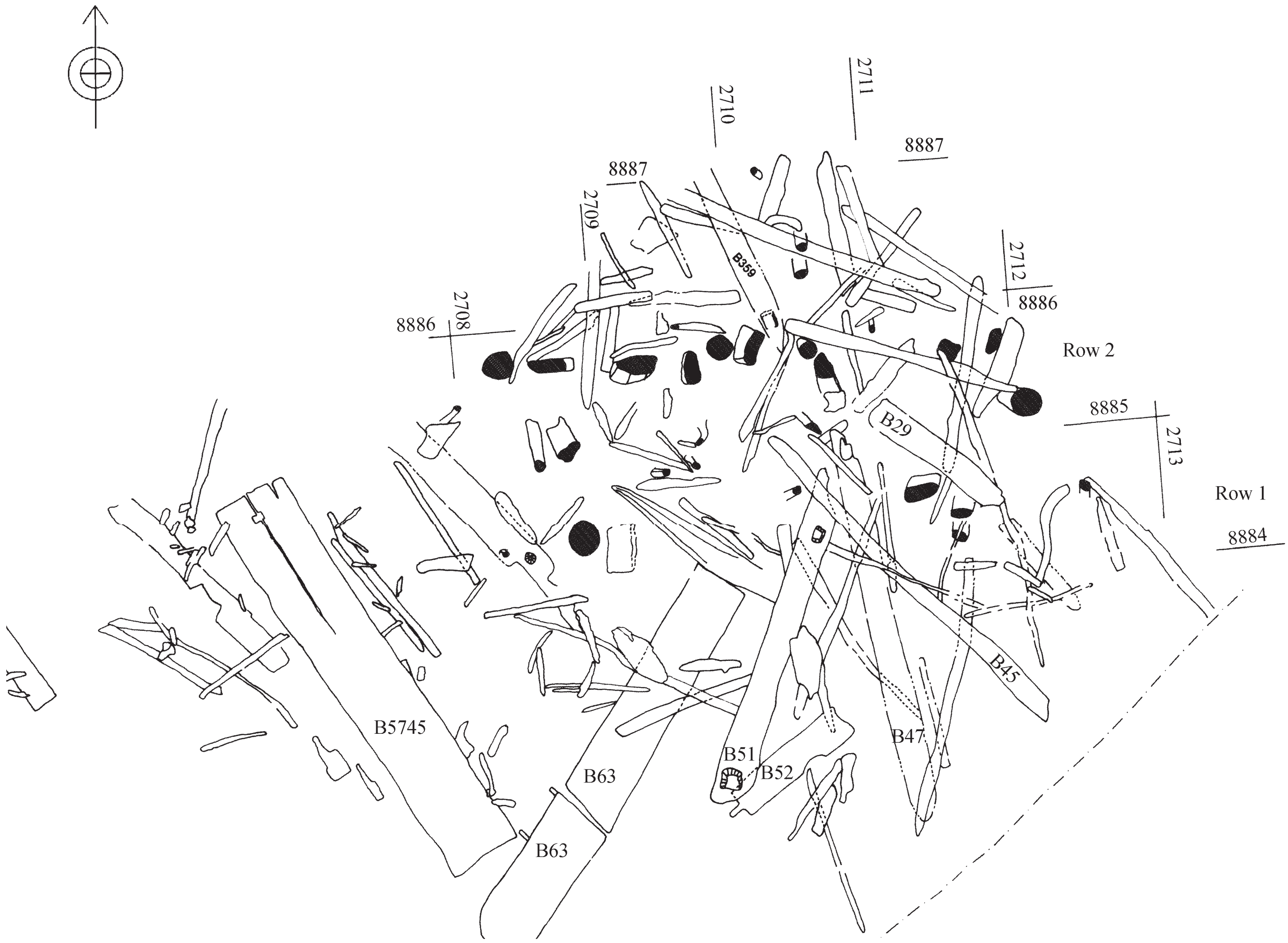


Figure 5.3. Timbers B63 and B5745 in Area 6

and timber of the platform. This is best illustrated by Timbers B63 (Pryor 2001, Fig. 6.30) and B5745 (Pryor 2001, Fig. 6.38), which lie alongside a number of other large timbers (Fig. 5.3). They are all near the edge of an area which was, almost certainly, a pool of water (Pryor 2001, 111). When Timber B63 was turned over, it was found to have deep grooves caused by extensive wet rot on the underside. This would indicate that it had lain in damp mud for a considerable length of time. This timber is tangentially split, and is more than 2500mm long, 457mm wide and 61mm thick (Fig. 5.4). The grain is perfectly straight and even, with no knots or other blemishes. Timber B5745 is very similar, although slightly larger, at 3000mm long, 600mm wide and 70mm thick.

We can learn much from these two huge timbers about the working and reduction of big trees. Timber B5745 has a tiny mortice which, it can be assumed, was used for towing. The first exposure of Timber B63 showed that one end appeared perfectly flat and square, as if sawn. Examined in a low, raking light, however, slight facetting could be detected, proving that this end had been trimmed square with an axe. This has to have been a bronze axe, and the work had to have been done while the wood was still green; the skill of the woodworker was extraordinary. At this point, there was

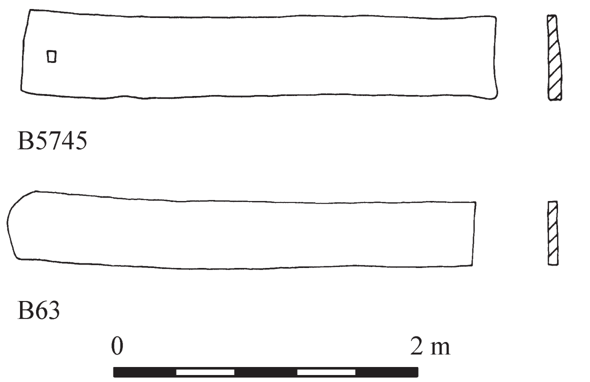


Figure 5.4. Timbers B63 and B5745

still no way of knowing whether trees as large as this could also have been felled with such small axes. Eventually it was possible to excavate and retrieve the other end of this huge timber, which still retained its felling scars. Given that the timber was sealed within the platform, the clear tool facetting on the felled end settled once and for all any discussion of whether bronze axes were capable of felling these huge trees. Because B63 and B5745 are tangentially split, it is also possible to get a better idea of the diameter of the original tree. The timbers are split out of quarters, but away from the centre, which means that this tree must have been more than 1.5m in diameter.

Trees of this great size were obviously available and the timbers derived from them appear to have been used for non-domestic purposes. The 'poolside area' of Area 6D presents a good example: 'the seemingly profligate use of very high quality timber, the pool itself, the possible portal, the deliberate destruction of a fine sword scabbard plate, and the disposition of dog bones all suggest that the poolside area was one of ritual importance' (Pryor 2001, 162).

The Big Tree

Even today large trees are acknowledged as special. They are the biggest living organisms that most people will ever encounter. The 'Big Tree' was already important in the Neolithic, as is well illustrated by the long barrow at Foulmire Fen in Cambridgeshire (Evans and Hodder 2006). The wooden structure inside the barrow, which dates to the early 4th/late 3rd millennium BC, was virtually all made from one huge tree. Already, however, the reduction of a huge tree into the component parts of a mortuary structure is sophisticated and confident, and even at this early date the techniques used were well established. The study of the tree rings (Morgan 2006), together with the study of the wood technology (Darrah 2006), establishes that all the planking was either full or half tangential planks. They are set so that the outside surfaces of the mortuary structure are also the outside of a tree, or trees.

The original tree used in the long barrow at Haddenham must have been at least 1.2m and possibly up to 1.5m in diameter, and was of very high quality, with even grain and no blemishes. Darrah (2006) has concluded that a tree 1.5m in diameter and 5m long, if tangentially split, could have produced all the timbers of the main structure with the exception of the two proximal posts 3684 and 3685. Other trees are used for additional components. There is little evidence to indicate whether the splitting and shaping of the timbers was done on site. Few woodchips were recorded or retained, but it does seem possible from the little evidence that has survived that at least some of the work was done on site, even *in situ* (Evans with Taylor 2006, 139), and this too may be significant, given what we now know about the admittedly much later timber circle at Holme-next-the-Sea (Brennand and Taylor 2003).

There is no direct evidence to indicate whether the timbers in the mound at Haddenham were aligned as they had been in the original tree. However, as the long mound is slightly trapezoidal, it seems reasonable to assume that the timbers were aligned to mimic the taper of the tree. Perhaps, too, the mound itself was mimicking, and becoming, the tree it contained. Whichever way the symbolism was expressed, however, the mound and the chamber within it surely reference a big tree: to enter the passage is to enter the tree through the roots and then to ascend within it.

The Big Tree next makes an appearance at the start of the Bronze Age in the timber circle at Holme-next-the-Sea in Norfolk, which has been dated to 2049 BC (Brennand and Taylor 2003). The most obvious manifestation is the inverted tree at the centre of the structure (Brennand and Taylor 2003, figs 1 and 15). It is difficult to calculate the precise diameter of this tree because it has been quite heavily worked, with all the bark and some of the sapwood having been axed off. Even allowing for this, it must have been more than a metre in diameter. The Big Tree is also represented in the structure in two other ways, however. Most of the individual timbers of the circle were not taken from particularly large trees, as most fall between 250 and 350mm in diameter. Some of them, however, are derived from the central tree (A), and were split out of the trunk higher up. These splits out of Tree A are treated differently from most of the other timbers: for example, they occur only in the panel opposite the entranceway (Brennand and Taylor 2003, Fig. 14); furthermore, the axes used on Tree A were never used on timbers of any other tree.

All the timbers of the circle are set edge-to-edge; most retained their bark, which was positioned on the outside. From a distance the monument would have resembled a huge log or tree trunk. This encircling 'tree trunk' also contained the inverted Big Tree, whose bark had been deliberately removed. The symbolism here may be more difficult to interpret than that of the long barrow at Haddenham, but it is, if anything, even more complex, multi-layered and powerful.

A structure which is, in many ways, similar to the monument at Holme-next-the-Sea was the oval barrow mortuary structure at Maxey (Pryor *et al.* 1985, 62–4). This structure was also made of edge-to-edge timbers, but in this instance they appear to be squared oak logs rather than half split trees. The timbers at Maxey survived only as charcoal and stains, so little other detail remained. It seems likely, however, that although the individual trees were more than 300mm in diameter they were probably not strictly Big Trees as they were unlikely to have come from dense forest. The structure was oval, like the 'circle' at Holme, and also had a narrow, restricted entrance. The reduction of the timber ensured that there would be no bark and the monument from a distance would have looked like a wooden cylinder or a debarked tree.

This structure, without its bark, contained a crouched burial. The Holme structure, with its bark exterior, contained an inverted tree. The two structures could be symbolic of different things, although it needs to be taken into account that the bark on the Holme structure would have gradually

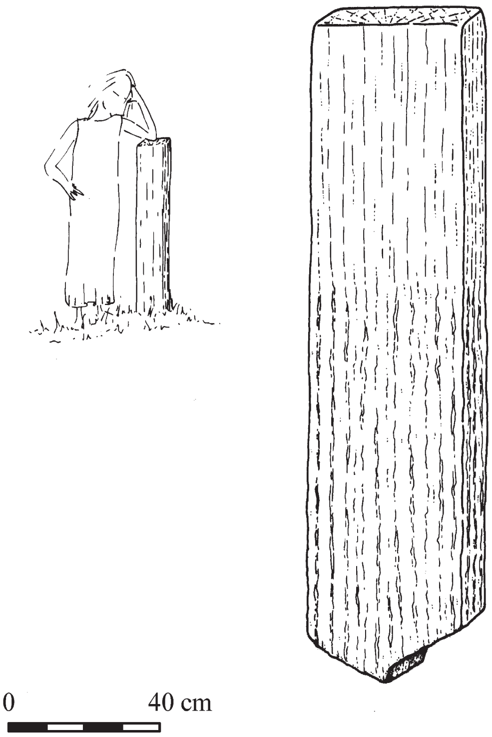


Figure 5.5. Monumental timber excavated at Pode Hole Quarry

weathered off. Eventually the Holme structure would also have looked like a wooden cylinder or debarked tree. The roots of the tree could also have cradled a body, perhaps left there during rites of excarnation. In the discussion of the mortuary structure at Holme, the likelihood that these circles were temporary or transitional is discussed (Brennand and Taylor 2003, 70). One possibility, not suggested there, is that this transitional stage in the construction of the monument was measured by the bark detaching and falling from the wall. The end of the time of transition would be when the 'tree' had debarked itself.

All the timbers discussed above were found in non-domestic contexts, but recently 'monumental timbers' have been excavated from watering holes in prehistoric agricultural landscapes. The first comes from excavations at Pode Hole Quarry at Thorney, Cambridgeshire, and was a large reused oak timber (Context 8335) which was found acting as a step in the bottom of a watering hole (Taylor 2009a). This timber was entirely of heartwood and, as such, would have been impossible to modify with bronze tools once seasoned (see above). It is reasonable, therefore, to assume that the timber is complete and unmodified, albeit reused. It was 1800mm long, 400mm wide and 80mm thick. The bottom end of the timber still retained the distinctive stepped shape of a felled end. It had been squared out of a half split tree of an original diameter probably in excess of 400mm. The lower part of the timber is heavily marked and grooved by wet rot, which is obviously not related to the reuse of the timber. When it was excavated it was set horizontally, but the rot shows that at some time it must have been vertical. The wet rot damage also indicates the depth of the original setting, and it is possible, therefore, to estimate the original height of the timber *in situ*. Scars left by wet rot indicate that the bottom 1080mm of the timber was set in damp ground, while the top 720mm must have been above ground (Fig. 5.5). Set like this, the timber would not have been visible over any great distance, but it would have been virtually immoveable, which suggests it must have been some kind of permanent marker (perhaps the equivalent of a solitary standing stone), rather than, say, a monumental 'totem pole'.

It is unusual for the full length of a vertical timber to survive. When they do survive, most are, almost by definition, redeposited, and for this reason there is rarely any indication of the original function. Among all the verticals which were excavated at Flag Fen, only three were retrieved complete (Taylor 2001, Fig. 7.33, nos 2, 5 and 8). All three survived intact because, although obviously shaped for insertion in the ground, they were all horizontal when excavated. The dimensions of these three timbers (4020 × 220 × 185mm; 1715 × 200–295 × 130–160mm; 2510 × 200 × 141) are all different; none was derived from particularly large trees and two are of alder (*Alnus glutinosa*) while one was of oak (*Quercus* sp.).

Vertical timbers usually survive *in situ* only below the old ground surface, and then the quality of preservation will depend on the level of the water table through time. This makes it very difficult to calculate original heights. It is, however, often taken as a rule of thumb that timbers are set with one-third below and two-thirds above ground. This is partly based on modern practice but is also a pragmatic response to a practical problem. One of the few clues to the fact that this may have been standard practice in the past was indicated by one of the complete timbers from Flag Fen discussed above. Timber B1421 is a modified alder tree trunk with a mortice in the sharpened tip (Taylor 2001, 203 and Fig. 7.33, 2). There is also a blind mortice 1500mm further up and an 'eared' housing joint at the top. This blind mortice could have been set at ground level to take a cross member for spreading the load. If this was the case, there would have been 1500mm below ground and 2520mm above, giving us slightly more than a third below ground – not far off the hypothetical 'ideal'.

In contrast, the timber Context 8335, from Pode Hole Quarry, had, as noted above, been set in such a way that more than half of it was below ground. Its bottom end had not been trimmed to a point and a pre-excavated hole would have been required for its erection. This would also have helped in placing the timber accurately, as it was not a suitable shape for pile-driving. The depth to which the timber was buried would have meant it was solid, and probably immovable, suggesting that it might have been a marker for an important boundary or location. It was plainly important that it could not readily be moved nor tipped over when leant on by people or rubbed up against by animals. Setting it up would have been a long job, as

would moving it. A sample of this timber was taken and examined by the dendrochronologist Ian Tyers at Sheffield University; rather unexpectedly, he was unable to match it with another chronology (I. Tyers pers. comm.). This is particularly intriguing given the proximity of Flag Fen, with its extensive chronology, and might suggest that this large timber had been transported some considerable distance.

A second oak timber, Timber 6, was recovered from a different site (PC259) in the same quarry. This also had many of the characteristics of a 'monumental timber'. Although a relatively short length (575mm) survived, and it was not very wide (200mm), it was nonetheless very thick (95mm) for its width. It was tangentially split out of a top-quality oak tree which must have been well over 400mm in diameter. The end which survived in reasonable condition had been trimmed square so, again, it would not have been suitable for driving-in. This end had been trimmed using a fairly straight blade, but the toolmarks are not sufficiently well preserved for accurate measurement. These blunt ends which require pre-excavated holes for their setting suggest that precise positioning of these timbers was important. This timber was also examined by Ian Tyers at Sheffield but, again, he was unable to match it with another chronology (I. Tyers pers. comm.).

Timbers from large oak trees occur throughout prehistory in contexts which appear largely to be functional. There are also some indications that practices changed through time. The Sweet Track in Somerset dates to the late 4th millennium and was constructed with some large timbers (Morgan 1979). The Baker platform and other slightly later tracks have much less timber and more split roundwood and it has been suggested that the larger, higher-quality trees may not have been available for track building after *c.*3200 BC (Coles and Orme 1983). Whether this was because all the trees had been felled, because techniques had changed or because trees had become too valuable for track-building is not clear.

The excavation of wood directly derived from domestic structures is unusual and, when it is found, it is invariably of small diameter. The material from Yarnton in Oxfordshire is a rare example of this (Hey in prep.). Large quantities of alder, ash, hazel and other species were used in domestic settings, but the size of the ubiquitous post-holes alone is sufficient to demonstrate that large timbers were rarely used for house contruction. Domestic structures needed to be easy to build and maintain with a relatively small workforce; the best raw materials for this kind of building work are roundwood poles, lightweight planks and quantities of relatively small, straight roundwood for the weaving of wattlework.

Even in later ritual structures, Big Trees become more and more unusual. The Iron Age post alignment at Fiskerton, for example, does not use Big Trees for the main verticals. Most of the wood is roundwood, the largest with diameters around 360mm. In fact there were only a few this large, and the bulk were much smaller: 260mm and less (Field and Parker Pearson 2003, Fig. 3.22). What is more telling, however, is that there was virtually no timber in the post alignment, and none of it was derived from large trees. The only Big Trees at Fiskerton are to be found in the form of logboats, for which large trees of reasonable quality are a necessity. Even so, one of the boats from Fiskerton had a large knot-hole which needed attention to make the craft water-tight (Taylor in prep.).

As time passed Big Trees would have become scarcer. By the Neolithic the great forests would have already been thousands of years old, and because forests are dynamic they would already have had gaps in the uniform stands of giant oak trees. As time passed oak trees perfect enough for a long barrow like Haddenham, or a huge boat, would have to be sought from further afield. The trees themselves were apparently indestructible, with new stems springing up where they had been cut down (certainly with most of the British native trees). Until recent times this ability to regenerate was the reason why some trees needed grubbing rather than felling. Grubbing a whole tree complete with roots was common and efficient in woodland management within living memory and is graphically described by Gertrude Jekyll (Jekyll 1899, 222). The central tree from Holme is an example of a grubbed tree. Grubbing would have left many 'tree-throw pits' and would have prevented resprouting, which was clearly desirable in land cleared for agriculture.

Huge trees grow so slowly they can seem to appear ageless, but smaller trees grow visibly every year and will be measurably much larger in a person's lifetime. As seedling trees, saplings and coppice can be seen to develop into usable raw material over a few seasons, prehistoric populations may well have deduced that huge trees must grow over a vast time scale. It may even have been apparent to prehistoric populations that there was only a finite supply of good, large trees, which must have became more and more scarce as time passed.

There does not seem to be a chronological progression from using complete trees, such as in the barrow at Haddenham, to the construction of symbolic trees, such as the circle at Holme. The structure at Maxey is a symbolic, barkless 'tree', but is much earlier than the symbolic tree at Holme, with its retained bark. The symbolism may lie in the components of the tree: live trees have bark, but trees with no bark are dead; felled trees with their roots still earthfast are not dead because the root system will produce new young stems, but trees which are grubbed and removed complete with their roots will not regenerate and are therefore truly dead.

Elaborate 'totem poles' and timbers with carvings have long been a popular theme of reconstructed timber structures (*e.g.*, Gibson 1998, 95). No evidence, however, has yet been found for carving of any kind on large timbers, and it now seems more likely that trees were considered too important in their own right to be 'desecrated' by carving. If the trees and the timbers derived from them were loaded with symbolism it may well have been considered presumptious (or worse) to deface them.

Large posts and timbers survive on most archaeological sites only as post-holes, but the original timbers were probably used in ways which were far more complex than a simple pattern of post-holes might suggest. The size of a timber and its reduction, together with the quality and status of the original tree, would all have had a bearing on the appearance and status of the final construction. A timber being used as a boundary marker would need to have authority if it was to be respected; in some instances this would have been provided by the status of the person who supplied it in the first place. The failure to match the monumental timbers from Pode Hole Quarry with the chronologies at Flag Fen may bear this out. It is not impossible that these trees were felled a great distance away, and authority can become enhanced with distance, as would have been the case with the Stonehenge bluestones or the concentration of Group VI axes around the Wash. There are further indicators of this in the construction of the timber circle at Holme. The Big Tree in the centre, the use of parts of that tree in a limited section of the circle and the restriction of certain axes/people to working only on those timbers is significant. The number of people who would have worked on the rest of the circle suggests that the structure of the group and the status of the individuals within the group were clearly defined.

Large oak trees are used for high-status structures from the Neolithic onwards. The Neolithic is the time when monumentality really begins and it is interesting to consider the role of the great trees in the construction of some monuments. The similarity between the shape of the long barrow and of the Big Tree is referred to above and leads to a new version of the old question: which came first?

6. Non-Human Bone from Flag Fen 2003, 2004 and 2005

Jill Hooper

Introduction

Two samples of bone material are discussed here. The first was retrieved from waterlogged deposits of the post alignment within the north-west Flag Fen basin in 2005 (FF05). The second came from a drier context within a dumped gravel surface on the landfall of Northey 'island' during excavations in 2003 and 2004 (FF03/04). The bone assemblage from FF05 was collected from trenches 2005/3 and 4, and that from FF03/04 came from three trenches (2003/1, 2003/2 and 2004/3) in an area which measured 25×15m. Each sample was collected by hand, with those from 2003 and 2004 retrieved from material excavated in a grid of 1m^2 contexts and passed through a 50mm wet-sieve. The two samples are discussed here separately as discrete units of analysis, with 2005 towards the end of the report. Constraints similar to those experienced by Halstead *et al.* (2001) within the platform and the Power Station post alignment also apply here in the form of the lack of stratigraphic correlation possible in the 2005 assemblage between the wood layers and the findspots of the bone samples. Even so, associated finds of pottery and metalwork would suggest a date probably within the Late Bronze Age.

The 2003/2004 assemblage was recovered from discrete layers of buried soil between interspersed layers of redeposited gravel. Unfortunately, direct dating of each layer was not possible, although the distribution of the bones was fairly composite within each trench; hence the sample is analysed here as a single unit. The finds assemblage is mixed, with Late Bronze Age metalwork and, predominantly, Middle Iron Age pottery, largely owing to water action and trampling. Previous evidence from inland field systems suggests that sites along the Northey landfall are broadly contemporary with the Fengate and platform sites of the Late Bronze Age (French and Pryor 1993), and the bone sample analysed here would fit into such a scheme.

The 2005 excavation recovered eleven bone fragments from an area located at the western end of the post alignment, also from a Late Bronze Age context, but closer to the Fengate site than the 2003/2004 assemblage.

Method of analysis

Both assemblages were analysed using the same zooarchaeological methods unless otherwise specified. Identification of the 2003/2004 assemblage was carried out by Jill Hooper and Elizabeth Henton, and that of the 2005 assemblage by Jill Hooper.

All complete specimens, anatomically diagnostic fragments and diaphyseal (shaft) fragments larger than 30mm were identified to taxonomic species (and where possible, genus), anatomical location, left or right side, completeness and degree of epiphyseal fusion. The identification of species and element was conducted with the aid of three zooarchaeological identification manuals (Schmid 1972; Cohen and Serjeantson 1996; Hillson 1992) and the reference collection at the Institute of Archaeology, University College London, UK. The data were recorded onto a Microsoft Access database and analysed using Microsoft Excel 2003.

In accordance with the methods set out by Grayson (1984), the number of identified specimens present (NISP) has been used here as it provides a simple count of the number of faunal specimens identified for each taxonomic group. It is important to emphasise that this measure suffers from two interrelated limitations: first, an element which has fractured into multiple fragments may be counted as more than one specimen; and, second, several elements/specimens may represent a single individual. In order to provide a more accurate measure of the relative frequency of species present, the minimum number of individuals (MNI) has also been calculated following White's (1953) method, using the presence of the left mandibular molar. The minimum number of elements (MNE) was also recorded. In addition, signs of human agency, including cut-marks, striations, butchery and charring, were recorded for every element, as were taphonomic features such as gnawing, fragmentation, preservation and the presence of pathology.

While a lack of sexually diagnostic features precluded the possibility of estimating sex in any element, determination of age at death was estimated using the tables of epiphyseal fusion developed by Silver (1969) and patterns of dental wear developed for cattle (Grant 1982), horse (Marsha

Taxon	*NISP*		*MNE*		*MNI*
	N	%	N	%	N
Bos (cattle)	119	16	66	30.8	8
Equus (horse)	117	15.7	45	21	4
Cow/horse size fragments	117	15.7	33	15.4	0
Cervus (red deer)	20	2.7	12	5.6	0
Sus (pig)	14	1.9	10	4.7	2
Ovis/Capra (sheep/goat)	45	6	28	13.1	4
Canis (dog/wolf)	2	0.3	2	0.9	0
Small mammal	8	1.1	4	1.9	0
Rodent	3	0.4	1	0.5	0
Bird (Indeterminate)	14	1.9	7	3.3	0
Anser (Goose)	2	0.3	1	0.5	0
Swan	2	0.3	2	0.9	0
Fish	9	1.2	3	1.4	0
Fragment <10mm	16	2.2	0	0	0
Fragment 10-20mm	98	13.2	0	0	0
Fragment 20-30mm	158	21.2	0	0	0
Total	744	163.4	214	100	18

Figure 6.1. Number of bone fragments assigned to species

Levine system, Hillson 1990) and sheep (Payne 1973). Measurements of diaphyseal length were taken only from specimens of biologically mature mammals – that is, examples in which both epiphyses had fused (Von den Driesch 1976).

Animal bone from 2003/2004

Identifications

Domestic mammals were identified as cattle (*Bos Taurus*), horse (*Equus caballus*), sheep/goat (*Ovis/Capra*), pig (*Sus domesticus*) and dog (*Canis familiaris*). Owing to the lack of diagnostic anatomical features it was not possible to distinguish between sheep and goat bones, and they were recorded as sheep/goat. Four wild species were identified: red deer (*Cervus elaphus*), badger (*Meles meles*), black rat (*Rattus rattus*) and, possibly, water vole (*Arvicola terrestris*). A tibia shaft fragment identified as that of a large dog could be assigned to wolf (*Canis lupus*) (Fig. 6.1). Identifiable bird bones were from swan (*Cygnus* sp.), goose (*Anser* sp.), herring gull (*Larus argentatus*) and tern (*Sterna* sp.). None were positively identifiable as domestic fowl (*Gallus f. domestic*). Fish bones, all from the head, were identified as mainly the lower mandibles of pike (dentary) and carp.

The element most frequently seen through the assemblage (Fig. 6.2) was the single tooth; this is problematic for analysis because of the number of teeth each animal has at any one time, including deciduous and permanent teeth. They have therefore been excluded from the discussion in this paragraph. There were 73 individual cattle elements, of which tibia (13) were the most numerous, followed by humerus (9) and radius (9). There was an equal number of bones from fore and hind leg. Interestingly, there were very few ribs. Of the 51 horse bones, slightly more fore leg elements (29) than hind (14) were present, and there were more pelvic bones (8) than for other species.

There were 33 sheep/goat elements; tibia (10) were again the most common, followed by vertebrae (8). Normal domestic food discard would result in more sheep ribs and bone from the fore leg. Pig bones were few (10) and consisted of humerus (3), phalanx (3), femur (2) and tibia (1). Red deer (17) was the only wild mammal present in any number. The humerus (3) was the more favoured element, but there were equal numbers from fore and hind leg. Five sections of antler, one of which had been worked, were present. There would, therefore, seem to be a bias towards leg bones in the assemblage, and particularly towards the fore leg in the horse bones and towards the hind leg in sheep.

Recovery, attrition and discard

The 2003/2004 bone assemblage is small (NISP = 744). In total, 117 fragments were cow/horse-like in density and a further 272 were unidentifiable fragments, resulting in a total of 389 unidentifiable fragments; this left 355 identifiable fragments, of which 121 were single teeth from cattle, horse and sheep/goat; these came from both upper and lower and left and right jaws. Recovery of small bones from small mammals was minimal and there were no amphibian bones. This is probably due to hand retrieval and the size of sieving, and given the water-edge nature of the site is likely to represent an underestimation. It also shows a bias to the more durable denser bones.

	Cattle	Horse	Cow/horse size frags	Red deer	Pig	Sheep/Goat	Dog/Wolf	Small mammal	Rodent	Bird (Indet.)	Goose	Swan	Fish	Unidentified	Total
Antler	0	0	0	5	0	0	0	0	0	0	0	0	0	1	6
Horn core	1	0	0	0	0	1	0	0	0	0	0	0	0	1	3
Cranium	3	3	7	0	0	1	0	0	0	0	0	0	3	18	35
Mandible	5	1	1	2	0	1	0	1	0	0	0	0	3	5	19
Tooth	45	59	2	2	4	12	0	0	2	0	0	0	0	3	129
Vertebra	4	2	2	1	0	8	0	0	0	4	1	0	0	1	23
Scapula	1	3	2	1	0	2	0	0	0	0	0	0	0	0	9
Humerus	9	5	3	1	3	1	0	0	0	0	0	2	0	0	24
Radius	7	6	1	1	0	0	0	0	0	0	1	0	0	0	16
Ulna	2	1	2	2	0	0	0	0	0	1	0	0	0	0	8
Radius+Ulna	2	3	0	0	1	0	0	0	0	1	0	0	0	0	7
Metacarpal	6	5	0	0	0	0	0	0	0	0	0	0	0	1	12
Rib	3	0	6	0	0	2	0	0	0	0	0	0	0	17	28
Pelvis	4	8	2	1	0	2	0	0	0	0	0	0	0	0	17
Femur	2	4	1	3	2	3	0	0	1	0	0	0	0	0	16
Tibia	13	4	3	0	1	10	1	0	0	0	0	0	0	0	32
Tarsal	3	1	0	0	0	0	0	0	0	0	0	0	0	0	4
Metatarsal	5	5	0	0	0	0	1	0	0	2	0	0	0	0	13
Sesamoid	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Phalanx	3	1	0	0	3	2	0	3	0	0	0	0	0	0	12
Unidentied flatbone	0	0	4	0	0	0	0	0	0	0	0	0	0	38	42
Unidentified longbone fragment	0	5	73	0	0	0	0	3	0	4	0	0	0	139	224
Unidentified fragment	2	0	7	1	0	0	0	1	0	2	0	0	3	48	64
Total	120	116	117	20	14	45	2	8	3	14	2	2	9	272	744

Figure 6.2. Number of elements per species

Preservation was generally poor (Fig. 6.3). In total, 389 fragments were too small to identify, 55 were heavily concreted with iron panned gravel, and 36 showed possible signs of butchery (24 with cut marks and 12 with possible chop marks). Most of the unidentified bone fragments were from multiple fracturing of long bones and may have been the result of marrow extraction. A large number of bones (124) had multi-directional linear marks possibly resulting from trampling (Behrensmeyer 1978) and/or water movement. Trampling may also have been responsible for the fractures and fragmentation. Since so few definite chop marks were identifiable, it is impossible to state definitely if the high degree of fracturing was due to human action, hoofed animals or a combination of the two. Nine bones showed definite evidence of gnawing (eight dog and one rodent), but many were missing both epiphyses and fusion surfaces, which might have been due to canid gnawing (Brain 1981), although they were not associated with puncture or gnawing marks. Six bones had definite bone-working scarring, including a horse distal metatarsal with fused tarsals from context 040. This had a linear V-shaped area which could have been removed to make a needle or spindle (Fig. 6.4). One naturally shed antler (410/62) had a circular cut around the brow tine (Fig. 6.5). There was no evidence of bones being burnt.

Taphonomic damage	*Frequency*
Trample marks	124
Roots	59
Concreted iron panning	55
Butchery	36
Heavily abraded	25
Excavation damage	10
Dog gnawing	8
Deep gouges	7
Worked	6
Rodent gnawing	1

Figure 6.3. Number of identifiable elements by taphonomic damage

Attempts to sex the bones failed because the required diagnostic features were absent, because castrates may have been present in the assemblage (Davis 2000) and because of the variations in size arising from possible incoming

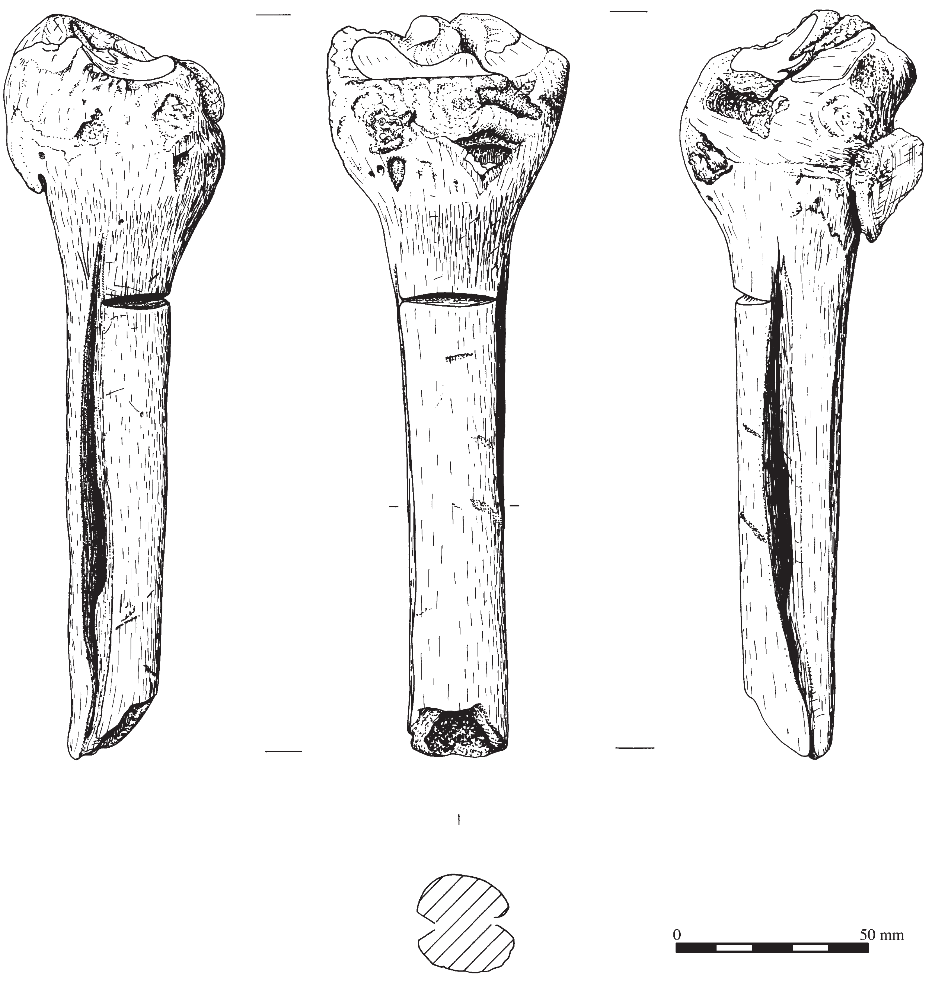


Figure 6.4. Horse distal metatarsal with bone cut removed

animals from other herds (Grigson 1982), or interbreeding, as, for example, with *Bos primogenius*. No obvious pairings or part skeletons were noted. Lower limb verses upper limb bones do not show a bias towards one species and neither is there a bias to one side of an animal (144 from the left and 123 from the right).

Attempts to age by teeth were problematic due to the poor quality of the teeth, mainly in terms of heavy iron panning and broken cusps. Moreover, ageing systems rely on patterns in the mandible of two or more teeth (Payne 1973; Grant 1982), and no mandibles within the assemblage had this many teeth remaining *in situ*; a mere seven had one tooth *in situ*. Two horse maxillas from the same animal had three teeth *in situ*, but no mandible. There were 120 single teeth from cattle, horse and sheep/goat. It was possible to differentiate cattle M1s from M2s (Klein *et al.* 1981; Beasley *et al.* 1993), and, using a combination of Grant's (1982) and Halstead's (1985) methods for assigning age stages, to ascertain that all individuals died at least 18 months after birth. Single horse teeth (60) are very difficult to identify, and ageing is problematic because of the similarities between the cheek teeth and the continual growth of the crown (Hillson 1992). However, using Levine's system (Hillson 1990) age ranges between two and 20 years were estimated. Age from single sheep teeth (12) could not be estimated to less than 20 months because of the lack of mandibular tooth rows. The patterns of dental attrition that were evident suggested that individual teeth came from mature animals, not from young animals (<18 months) or neonates.

Ageing through bone fusion was used for 28 cattle bones. One humerus and one radius from different contexts came from animals that died before 18 months of age. Seven metapodials were from animals over 18 months of age and all other bones were from animals older than 3½ years. One right-sided horn core (621/133) is at Armitage's (1982) stage 5/6 and is therefore that of an old adult.

Of the 25 horse elements with epiphyses, 23 were fused, while one distal radius and one distal metatarsal were in the process of fusing. Eight of the bones had fused epiphyses at both ends, distal and proximal fusion of the same bone may occur at different ages, by taking the later fusion of each bone, the age at the time of death for these eight bones could be estimated as more than 3½ years. In context 040 there were three metatarsals, of which one distal metatarsal was fusing (fusing is at about 16–20 months) and another distal epiphysis was fused to three tarsals – a condition called spavin that is usually seen in old animals. Therefore the horse remains, with only one exception, appear to be from mature animals aged 3½ years or more.

Nine sheep bones could be used for ageing. One unfused femur suggested that the animal died before the age of three years, while one unfused tibia gave an age of death of less than 1½ years. The other seven bones are from animals of three years or more. Four pig bones were diagnostic for ageing; all suggested animals of 3–3½ years or over. The overall impression from the domestic animal remains is that they seem to be mainly from mature animals of about 3–3½ years or over at the time of death.

The nature of the animals discarded

Taking the 2003/2004 assemblage as a whole, there does not appear to be any pattern suggesting anything other than single element discard regardless of context; that is, there were no matches of elements from the same limb. A total of 144 bones were from the left side and 123 bones were from the right, therefore showing no particular bias to either one side.

The superficial multiple directional linear marks on 27% of the bones may be due to impact against the ground through water movement (Behrensmeyer 1978), trampling by animals (Behrensmeyer *et al.* 1986), or a combination of the two.

Figure 6.5. Antler with circular cut

In total, 120 cattle bone fragments were identified to anatomical part; of these, 42 were single teeth. 22 bones were from the right side and 14 from the left, presenting a variation not significant enough to suggest a bias. Tooth-wear evidence suggests that individual cattle died after 18 months, supporting adult bone fusion patterns.

There were 116 horse bone fragments identified to anatomical part, including 60 teeth. Context 044 contained 26 skull fragments (counted as one) which could be pieced together; the mandible was absent, but the right and left maxillas, both with M3 M2 M1 and P3 all *in situ*, were present. There were no teeth *in situ* in any mandible. Single teeth showed a range of wear suggestive of mature animals, but no abnormal wear patterns were noted to suggest anything other than mastication. One fragment of acetabulum (791/242) displayed two long, deep gouge marks, possibly from dismembering, and, as previously mentioned, a metatarsal fused to three tarsals, from context 040, had evidence of bone working.

In total, 44 sheep bone fragments were identified to anatomical part. Of these, 12 were single teeth, while 12 bone fragments could be assigned to the left and six to the right. One left horn core was that of a mature adult animal.

Thirteen pig bone fragments were assigned to anatomical part. Two right-sided humeri, one right-sided radius and ulna, two femurs, of which one was right-sided, and a single right-sided tibia; giving a right to left bias of 5:1, too small a sample to be statisically significant. All bones came from animals of 3–3½ years or older. Only two bones came from the same context, suggesting single element disposal.

In total, 19 deer bones could be assigned to anatomical part; five of these were fragments of antlers. Specimen 410/62, a naturally shed antler, had a circular cut around the base tine and may have been used as a tool, the beam being held in the hand and the base tine being used to lash and secure another material (Fig. 6.5). All samples were from mature animals.

Only two bones could be identified as dog, in contrast to the 79 found at the Power Station post alignment site (MNI 10) and the 60 from the Flag Fen platform site (MNI 4) (Halstead *et al.* 2001). One tibia shaft was that of a large dog or wolf; its presence was concurrent with previous findings suggested to be evidence for hunting dogs (*ibid.*).

Animal bone from 2005

Identifications

The 2005 assemblage was particularly small (NISP = 11). Of the 11 NISP, nine represent four MNI. Species identified were horse (*Equus caballus* – left humerus, left radius and left ulna), cattle (*Bos taurus* – metacarpal, two refitting fragments), pig (*Sus domesticus* – left scapula, left humerus and left tibia) and teal (*Anas crecca* – humerus). There were two unidentifiable diaphyseal fragments and three very small friable fragments. Recovery of bones from small mammals and amphibians was nil, but this may have been due to hand retrieval with no dry or wet sieving.

All bones except the delicate juvenile scapula were in good condition. Signs of root action were present but there was no evidence of gnawing, butchery or multi-linear trample marks, suggesting burial immediately after discard.

The assemblage included the articulated remains of a left humerus, radius and ulna of a horse, and an unfused left scapula, humerus and tibia from a juvenile pig, suggesting a bias to the left side. Both the horse proximal humerus and the proximal olecrannon of the ulna were missing, there was no evidence of gnawing; fusion of both epiphyses is at about 3½ years. Fusing at the distal end of the radius was also indicative of a similar age (Silver 1969), and suggests the horse was about 3½ years old at the time of death. The pig humerus and tibia were very small with no epiphyses, and the unfused surface of the scapula ages the individual at less than 12 months.

Discussion

The 2003/2004 assemblage indicates single element disposal, whereas in the 2005 assemblage articulated limbs were encountered. The 2005 assemblage is too small to be statistically significant, but part skeletons and paired or articulated body parts were also found at both the Flag Fen platform and Power Station post alignment sites (Halstead *et al.* 2001). This assemblage, which is situated at the western end of the post alignment, relates more closely to previous findings in this area than it does to those of 2003/2004, further to the east.

The superficial multi-linear marks of the 2003/2004 bones suggest trampling by animals. As has already been noted, gravel was deposited in layers at this water-edge site to 'firm up' and consolidate the area, probably so that livestock could reach the water to drink, reinforcing the suggestion of trampling. Arguably, the bone may also, in part, have been placed there for the same purpose. The heavy fragmentation of compact bones and the lack of more delicate bones may also be explained by trampling. The 2005 bones, located within the wet basin, showed no signs of trampling or gnawing and are likely to have been buried soon after discard.

Heavily fragmented bones (389 unidentifiable fragments to 355 identifiable fragments, of which 121 were single teeth) were included in this analysis as they may be the product of marrow fat extraction. To have ignored them would be to have underestimated this important use of bones. Only one bone showed signs of burning, while 36 showed signs of butchery and seven had deep gouges.

The relative low numbers of vertebrae, ribs, mandibles, scapula, and pelvic and toe bones suggested that there had been some selection in bone discard. Vertebrae and rib from cattle and sheep and scapula from sheep are often associated with human consumption and domestic food waste assemblages. The few that were found were in sufficiently good condition that the survival of more would

be expected, had they been placed there. Smaller and lighter bones may conceivably have been carried away by water action, in which case the assemblage may reflect the greater durability of denser bones and/or the disposal of selected body parts. This is further supported by the low density of skull bones, vertebrae and pelvic and toe bones, all of which would be expected from a butchery site.

The predominance of older individuals in the 2003/2004 assemblage can be interpreted as reflecting multi-purpose husbandry, in which livestock provided traction, wool and milk, before being used for meat, hides and material for tools and so on; six bones showed definite signs of being worked. By contrast, the 2005 bones were from young and immature animals, a trend more in keeping with that of the Flag Fen platform site.

Although both the 2003/2004 and the 2005 bone assemblages appear to be part of a process of selected discard (the 2003/2004 being that of single element disposal, and the 2005 of part skeleton and articulated bones), there is a clear difference in the attributes of each assemblage, possibly implying that different parts of the Flag Fen landscape allocated specific meaningful patterns to animal usage.

7. The Application of Oxygen Isotopes and Microwear from Cattle Tooth Enamel at Fengate and the Flag Fen Basin

Elizabeth Henton

Introduction

In this paper we use scientific evidence from microwear and oxygen isotopes in cattle tooth enamel to elicit information about the first and last days of an animal's life, providing a skeleton map of key events in its management history. Having assessed the feasibility of interpretation of cattle ethology and the later Bronze Age Flag Fen landscape and environment, variety in these histories will be used to infer degrees of specialisation and other aspects of contemporary society.

While it is often assumed that the material and the ideological were far more integrated in the past, testing this idea is is not always straightforward. This chapter presents a model where scientific evidence predicts and tests the degree of integration of Fenland society in the later Bronze Age. Preliminary testing of the model is limited to a pilot study taken from two Fenland assemblages, which produced some thought-provoking results despite its small scale.

The model asks how the integrated landscape of field systems, drove roads and the post alignment was reflected in cattle husbandry practices. Were local inhabitants managing viable herds solely for domestic purposes, or also for votive offerings, feasting, exchange and networking? If the latter, did the social activities support or undermine domestic husbandry? Were herders living subsistent lives, mere bystanders to more wealthy activities; or were they, too, participants?

In large bone assemblages herd composition and slaughter practices may be inferred from age, size and sex profiles. Patterns suggesting specialised (*e.g.*, Entwistle and Grant 1989; Legge 1981; 1989), subsistent or mixed economies (*e.g.* Halstead 1998b) are well established, though controversial. When this evidence is integrated with archaeobotanical interpretation the farming schedule, the wealth and size of the economy and any consumer/producer relationships may be proposed. However, such inferences cannot be made for small assemblages, and interpretation relying on ethnographic information remains speculative.

Later Bronze Age cattle husbandry around Flag Fen

The importance of Flag Fen as a later Bronze Age centre of ritual and animal husbandry, set within a palaeoenvironment where arable farming and animal husbandry could flourish in a liminal ritual landscape, is well established and will not be revisited in depth in this chapter.

The later Bronze Age animal bone assemblages found around Flag Fen are mainly cattle remains. The Fengate assemblage is about 70% cattle and probably represents redeposited domestic waste (Biddick 1974; Pryor 1974; 1980). The Flag Fen post alignment and platform assemblages also included paired and articulated unbutchered elements of large dogs, cattle and horse, which are interpreted as representing ritual deposition as well as domestic waste (Halstead and Cameron 1992; Halstead *et al.* 2001).

The 2003/2004 animal bone assemblage was retrieved from a phosphate-rich, hoof-marked area interpreted as a point of entry onto the basin near the post alignment (Chapter 3, this volume). The uneven distribution of cattle body parts suggests that some were waste from ritual activity and high-status feasting (Chapter 6, this volume).

Cattle may be moved to pasture, or the food may be moved to the cattle (Russell 1988). The well-drained fields and seasonally flooded meadows of Flag Fen provided the pasture, and the summer grazing of meadows allows time for the fields to recover from poaching and parasite infestation (Chang and Koster 1986). This increases the availability of winter pasture and decreases reliance on fodder.

If, however, working animals are tethered away from pasture, or if wet conditions restrict meadow access, fodder becomes necessary (Forbes 1998; Russell 1988). Cattle are adapted to optimise grassy fodder, with hay being the preference (Forbes 1998). It has the advantage of a convenient harvest timing that does not stretch labour resources, unlike leafy-browse collection (Halstead 1998a). Leafy browse is reserved for times of resource stress (Halstead 1998a), whereas more nutritious grain and bran from arable farming improve lactation, body weight and

work performance (Forbes 1998). Grain may also be given as a last meal before sacrifice (Mainland and Halstead 2002). In the Flag Fen landscape all of these resources were available (Scaife 1992).

Cattle might be brought to this centre from outlying areas. They can be droved long distances with minimal labour costs (Haldane 1973; Lucas 1989), and in the Fengate fields will have quickly replaced weight loss resulting from droving. Autumn culls and stock exchanges are often times of social networking, feasting, and ritual activity (Haldane 1973; Dahl and Hjort 1976; MacCormack 1981; Keswani 1994). At Flag Fen, the post alignment continues on from the main stockyard drove road, which formed a major access route for stock to be moved through the Fengate landscape, and Pryor (1996) suggests that this is no coincidence.

Tooth microwear

Teeth preserve well in the archaeological record and their microwear is not a product of taphonomy (Mainland 1998a; 2001). Microwear provides a direct relationship between fodder and animal, and is precisely associated with the recent foddering events prior to the animal's death (Mainland 1998a).

Under a high microscope resolution surface marks on tooth enamel may be observed as striations and pits at varying orientations to and densities on the tooth. Signatures correlate to dietary preference. Dedicated browsers have less total microwear but proportionally more pits, while dedicated grazers have more microwear and proportionally more oriented striations (Solounias and Moelleken 1992).

Mouth action contributes to three different wear types in caprines. Tugging on leaf browse with a crunching action produces large irregular compression pits at varying orientations, whereas ruminating on grasses, moving the jaw sideways, produces highly oriented striations (Mainland 2000). Small circular pits of <3 microns are produced by suction from glutinous foods such as grains (Mainland and Halstead 2002). The density of features increases when grazing is on over-stocked, poached or muddy winter pasture (Mainland 1998b; 2001), primarily because of the ingestion of grit. However, dry hay produces the same low feature densities as summer graze (Mainland 2003).

In order to compare caprine microwear signatures to those of the archaeological cattle it is first necessary to establish a modern baseline. The Chillingham Wild Cattle skeletal collection in the Natural History Museum will be used for this purpose. As dedicated grazers on unimproved lowland grasses, these cattle ignore browse and refuse soft foods (Hall 1988) ; they will only eat hay that has been collected from their own pastures (Widdows A., Chillingham Wild Cattle Reserve Warden, pers.comm. 2005).

The methodology for capturing and quantifying microwear broadly follows that used by Mainland. Software created by Ungar (2002) analyses the total number of features, the percentage distribution of all pits and striations, and the pit length.

Oxygen isotopes

Domesticate remains from settlement contexts usually derive from animals that died as a result of human actions shortly before primary deposition, and analyses of this evidence focus on culling decisions and carcass uses, whereas bone that has been worked or found in ritual contexts might have been conserved long after the animal's death. While herd profiles and pathologies indicate the use of the animal in years preceding death, and tooth enamel microwear elucidates conditions in the days before death, oxygen isotope signatures in tooth enamel take evidence back to the animal's birth.

These signatures relate to the months of enamel formation (Sealey *et al.* 1995; Fricke and O'Neil 1996; Iacumin *et al.* 1996; Kohn *et al.* 1998). Enamel forms from crown to cervix in a complex but sequential manner, and thus samples taken along its length preserve a time series (Fricke *et al.* 1998; Balasse *et al.* 2002). This model uses second mandibular molar enamel, which is formed between one and twelve months (Beasley *et al.* 1993).

Enamel oxygen isotope values derive from ingested water (Darling and Talbot 2003), which cattle find in small water bodies and leaf surfaces (Fricke and O'Neil 1996; Fricke *et al.* 1998; Balasse *et al.* 2002). Such surface-waters isotope ratios correlate highly to seasonal precipitation and evaporation (Fricke *et al.* 1998; Balasse *et al.* 2002), as do those of shallow standing water in the Fens, in rivers or in small wells (Darling 2004). When compared to the international standard (Vienna Standard Mean Ocean Water), the mean of these seasonal $\delta^{18}O$ signatures gives regional values that have been mapped for the Holocene in this country (Darling *et al.* 2003; Darling 2004; Fig. 7.1).

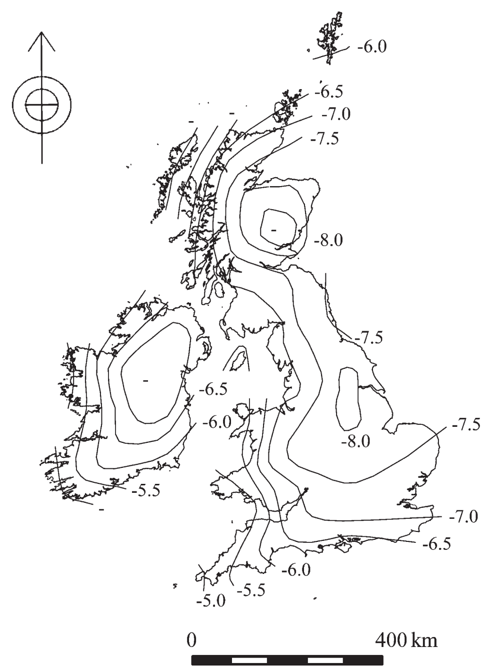


Figure 7.1. Contour map of $\delta^{18}O$ (VSMOW values) in Great Britain and Ireland (after Darling et al. *2003ii, p. 189)*

Ingested water values are offset positively in body water (Mashkour *et al.* 2002), with known constants for larger taxa (Bryant and Froelich 1995; Fricke *et al.* 1998). Suckled milk values are slightly offset further, but this effect diminishes rapidly as weaning progresses in the first four months.There are established protocols for sampling the tooth enamel (*e.g.* Balasse *et al.* 2002), and for analysis by isotope ratio mass spectrometry. The $\delta^{18}O$ values in enamel may be converted to those for ingested water using established calibrations (Bryant and Froelich 1995; Iacumin *et al.* 1996; Mashkour *et al.* 2002), with a 0.2 ‰ margin of significance:

$$^{18}O_{phosphate} = (0.988 * \delta^{18}O_{carbonate}) - 8.5$$
$$\delta^{18}O_{ingested\ water} = (\delta^{18}O_{phosphate} - 27.21) \div 1.48$$

The series of samples along the tooth column provide a seasonal curve over the first year from birth, which may also be averaged to give regional $\delta^{18}O$ values.

The model

Figure 7.2 models the tooth microwear evidence and relates it to foddering regimes, which are in turn related to different management solutions to seasonal stress and economic demands. It is possible to ask questions about the underlying economy and social demands (see last column). Stressed or subsistence economies may be limited to providing a winter diet based on poached pastures or less nutritious leafy browse, while economies that may be deemed more successful or integrated might supplement winter diets with grassy hay. Whether driven by piety, social aspiration or obligation, farmers might also provide more expensive soft grains to animals destined for ritual slaughter.

While microwear analysis concerns itself with the time of death, the long-term goals of the farmers and the trajectory of each animal can be investigated only if there is matching information about the first few months of life. Oxygen isotopes provide three useful types of information (Fig. 7.3): (1) evidence of on-site birth, (2) evidence of differing watering regimes and (3) evidence of off-site birth. The latter situation demands an explanation for an animal being found on-site at death. Ethological and ethnographic information has established the feasibility and limitations of long-distance droving, and archaeological evidence has established that cattle remains at other later Bronze Age elite and ritual sites had come from far afield.

The final stage of the model sets the 'last meal' information against the 'place of birth' information (Fig. 7.4). This matrix refines and also expands the interpretations, demanding explanations for husbandry activities that fit both ends of the animal's life. Thus, a suggested use for each animal may be inferred, and any variety between animals may be explained in terms of specialisation or diversification,

Microwear resulting from mouth action	*Fodder type*	*Soil ingestion*	*Amount of microwear*	*Regime at time of death*	*Management interpretation*	*Economic interpretation*
More, larger pits with lower incidence of alignment	browse	very low	less features	woodland or fallback browse	Herded or left to wander. Browse supplement in stressed conditions	A less organised subsistence system
More striations, with higher incidence of alignment	grass	higher	more features	winter poached pasturing	Pastured in fields and meadows, with more overstocking in a wetter landscape	An organised system under stress
		moderate	less features	summer, good pasturing	Pastured in fields and meadows with ample rich pasturage in a well drained landscape	An organised, successful system
	hay	not distinguishable from summer grass		hay fodder, stabling	Diet supplements for milking or working cows, or during periods of pasture stress.	An organised, system with financial backing
More small, circular suction pits	soft bran, oats etc	very low	moderate	special diet and treatment, stabling	Selected for special purposes such as ritual or feasting	A wealthy system providing cattle for a range of uses

Figure 7.2. Model of microwear signatures

	Absolute values	*Amplitude of variation*
1	Typical of region / not tyical of region	Within cluster for site / outrider
2	On-site or nearby / off-site or far-away	Similar watering regime / different watering regime
3	Born on-site or nearby / droved in before death	Born on-site or nearby / born under different watering regime

Figure 7.3. Model of $\delta^{18}O$ value signatures

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="5">Microwear interpretation</td></tr>
<tr><td>A less organised subsistence system</td><td>An organised system under stress</td><td>An organised successful system</td><td>An organised, system with financial backing</td><td>A wealthy elite system</td></tr>
<tr><td rowspan="2">Isotope interpretation</td><td>Born on site or nearby</td><td colspan="3">Raised for settlement use</td><td>Raised for local use or food or elite feasting</td><td>Raised mainly for elite feasting or ritual offering</td></tr>
<tr><td>Born nearby then droved elsewhere, then returned to Flag Fen
Born off-site, droved in before death</td><td colspan="2">Exchanged in trade or debt payment</td><td>Exchanged for trade or breeding</td><td>Brought on site for breeding exchange or elite feasting</td><td>Brought on site for elite feasting or ritual offering</td></tr>
</table>

Figure 7.4 Synthesis of microwear and isotope interpretation (shaded grey)

which in turn are related to the economic conditions and ideological imperatives of the society.

The pilot study

Microwear images were captured from fourteen second mandibular molars from the Late Bronze Age Fengate assemblage (labelled FNGA, FNGB and so on) and eight from the Northey 'island' assemblage (FFA, FFB and so on). The modern baseline was established from eight Chillingham cattle teeth (*e.g.*, CHA). Oxygen isotope values were taken from a series of enamel bands of five of the archaeological teeth chosen at random: FFD, FFE, FFG, FNGG and FNGJ. Most of these cattle died as young adults. The contexts of each tooth are listed in Appendix 4.

Tooth microwear results

Data obtained from the Chillingham cattle – the modern baseline – suggests that they feed exclusively on graze and hay, in and from unstressed meadows. Their microwear signatures all have oriented striations, as expected, but despite this they usually have as many pits. Mainland has observed that caprines feeding on graze and hay do not have high pit numbers; it is probable that cattle have more due to their larger, clumsier mouth morphology. The only summer death, CHG, has little to discriminate it from the winter deaths, agreeing with caprine studies that hay and graze signatures cannot be distinguished.

The ratio of pits to striations are similar for the Chillingham, Fengate and Flag Fen results (Fig. 7.5), the greatest variability being in total numbers. This confirms that later Bronze Age cattle conform to their ethology as grazers, and that soil ingestion is the greatest variant. The three groups show some clustering, most obviously in the Fengate results, that might reflect subtle pasture differences. However, statistical analysis using single factor ANOVA shows that this variance is not significant.

The clustering of Fengate results suggests that diet was similar throughout the year (Fig. 7.6). Only FNGG had a markedly higher total feature count, suggesting that it may have died after winter graze, whereas others died in summer or were given hay in winter. While the pit:striation ratio is fairly constant, the size of pits separates this result into the

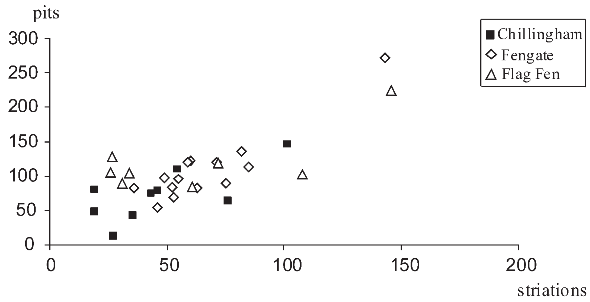


Figure 7.5. Scattergraph of the pit: striation ratios comparing archaeological assemblages to the modern baseline (after Chillingham)

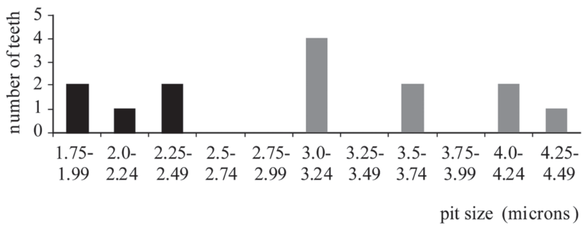


Figure 7.7. Fengate material, microwear separation by pit size

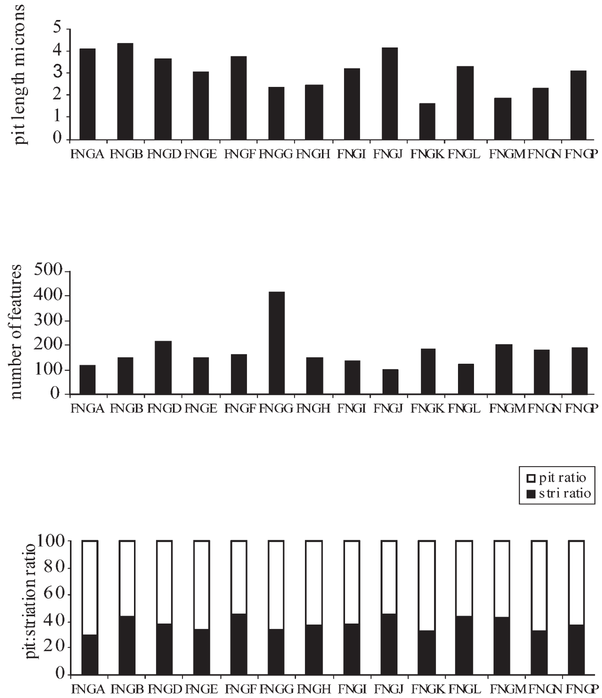


Figure 7.6. Microwear results for Fengate cattle

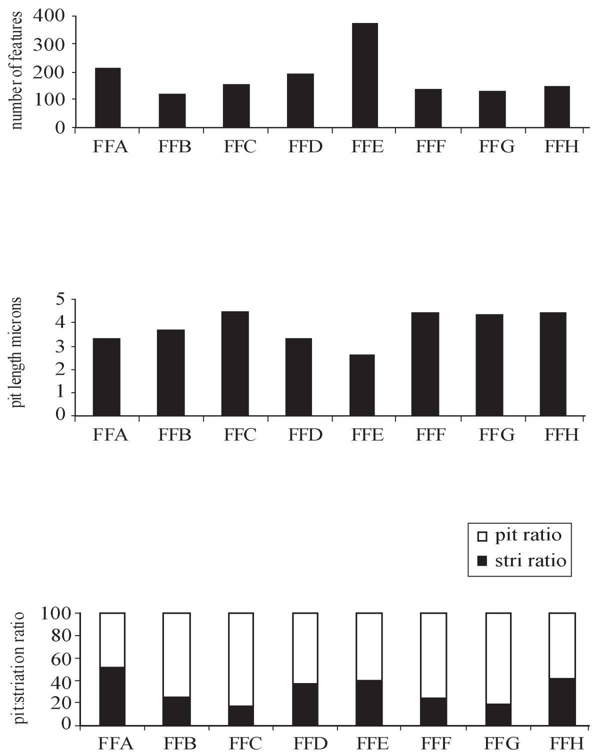


Figure 7.8. Microwear results for Flag Fen cattle

following two groups (Fig. 7.7): those with larger pits and a low total feature tally (FNGA, FNGB, FNGF, FNGI, FNGJ, FNGL) might have been fed dirtier hay or even browse, while the second group, FNGK and FNGM in particular, have high numbers of very small pits (<2 microns). In the absence of baseline information for comparison, the known suction effects of soft food will be put forward as the best explanation for this signature in cattle.

Results for Flag Fen are more varied (Fig. 7.8). FFE has a high number of very small pits, (<2microns), suggesting that it might have been fed on soft food. FFA has larger pits and a high feature count, both associated with muddy coarse material, possibly tough summer water-meadow reeds and rushes. Four specimens (FFB, FFC, FFF and FFG) have fewer features and more large pits, a pattern typical of a browse diet.

Isotope results

All $\delta^{18}O$ values have been calibrated for ingested water (Fig. 7.9 and 7.10). This small pilot study, with no duplicate sampling, has no formal assessment of error but preliminary calculation suggests that the 0.2‰ significance is ample.

The near-sinusoidal curves for FFG (minus the youngest band) and FFD (one band unsampled) confirm that an M2 cattle tooth gives nearly a full year's signature. However, the position on the curve of the first reading is different for each. FFD represents a spring-born calf, before enriched summer values, whereas FFG is autumn-born, before winter depletion. They also have different mean values: FFG (at -7.5‰) is typical of the Fenland basin, while FFD (-8.44‰) has values more typical of eastern upland regions, the nearest being the Peak District. They have a similar range of very dampened values (Fig. 7.9), for which there are two possible explanations: either the weather was

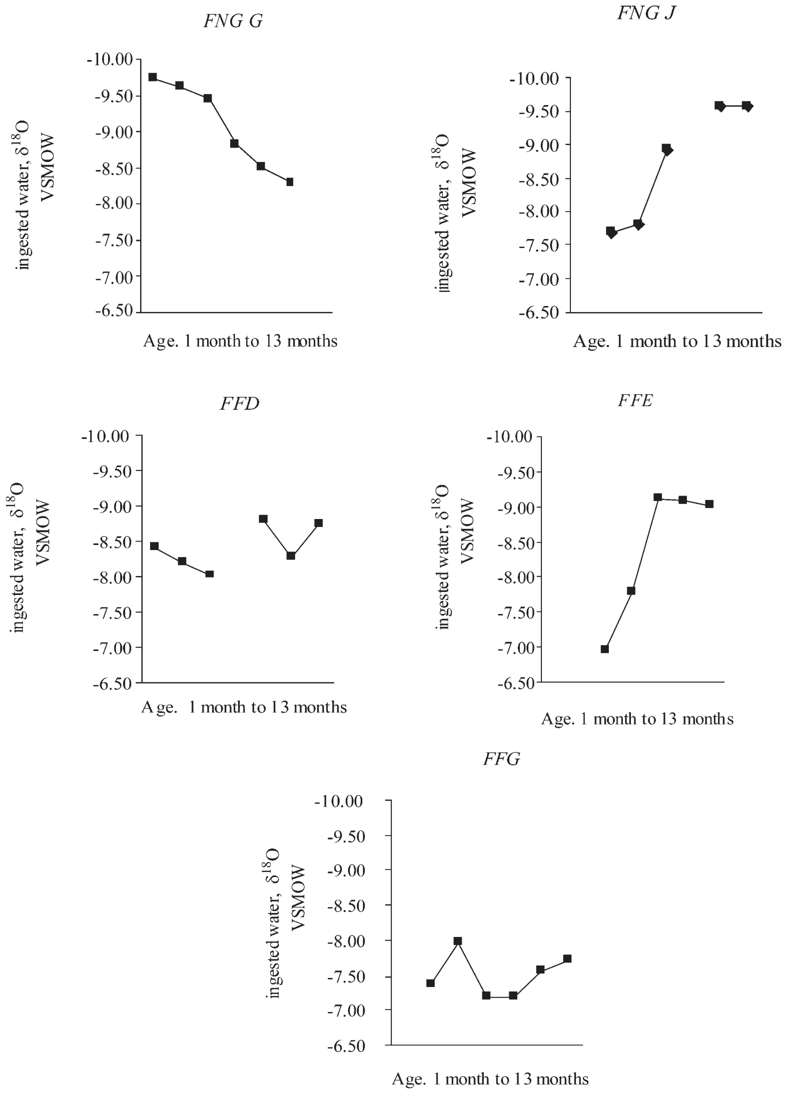


Figure 7.9. First year oxygen isotope curves for each tooth

particularly equitable, or they had access to more averaged water. While flattened summer readings might result from drinking standing marshland water or stored winter water, lowered winter readings are more difficult to explain.

Even after extrapolating the absent data due to tooth wear (FFE, FNGJ) or unsampled bands (FNGJ), the typical sinusoidal curve is absent in the other teeth. Nevertheless, the whole year of enamel formation is represented, so a sinusoidal curve should be expected. The only explanation is a significant change of watering regime during their first year, as they moved to, or through, regions with different values.

FNGJ and FFE would appear to have similar life trajectories. They were born near Flag Fen in autumn, but moved some distance inland, where they drank upland water with depleted $\delta^{18}O$ values during spring and summer. However, it is important to note that they were then brought back down to the lowland since they died at Flag Fen at least six months later.

The mean $\delta^{18}O$ values of FNGG are very high, suggesting that it was born in spring, (before enriched summer $\delta^{18}O$ values) in an upland region even further north than the Peak District with cold, wet depleted $\delta^{18}O$ values, before being droved downhill during the summer, ingesting increasingly enriched water on the hoof, and over-wintering in a region to the east and still upland of Flag Fen. This long droving continued to Flag Fen itself when the animal was older.

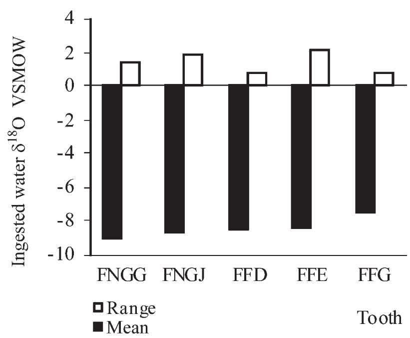


Figure 7.10. Range and mean of $\delta^{18}O$ values for each tooth

Interpretation

Returning to the model, it is possible to use it to interpret the microwear and isotope signatures from each animal. The microwear feed signatures are associated (as suggested in Fig. 7.2) with probable husbandry practices set within the possible economic security of the society (Fig. 7.11). When this further interpretation of probable practices are added to the original model a complexity of practices begins to emerge (Fig. 7.12).

Thus, the signatures for FFB, FFC, FFF and FFG suggest that the husbandry regime for these individuals relied more

Specimen	*Microwear features (pit : striation ratio 'normal' unless specified)*	*Interpretation of final foddering*	*Interpretation of animal husbandry system*
Fengate			
FNGA	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGB	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGD	'Normal' pit : striation ratio, total features, larger pit size	Graze or hay	An organised system with financial backing
FNGE	'Normal' pit : striation ratio, total features, larger pit size	Graze or hay	An organised system, possibly with financial backing
FNGF	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGG	High feature numbers	Winter graze	An organised system, possibly under stress
FNGH	'Normal' pit : striation ratio, total features, larger pit size	Graze or hay	An organised system, possibly with financial backing
FNGI	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGJ	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGK	More small pits	Grains and chaff	A wealthy system providing cattle for a range of uses
FNGL	More larger pits	Dirtier hay or possibly browse	Less organised subsistence, or organised but under stress
FNGM	More small pits	Grains and chaff	A wealthy system providing cattle for a range of uses
FNGN	'Normal' pit : striation ratio, total features, larger pit size	Graze or hay	An organised system, possibly with financial backing
FNGP	'Normal' pit : striation ratio, total features, larger pit size	Graze or hay	An organised system, possibly with financial backing
Flag Fen			
FFA	More features Less but larger pits	Muddier, coarser reeds etc.	An organised system, possibly under stress
FFB	Less features More larger pits	Browse fodder	A less organised subsistence system
FFC	Less features More larger pits	Browse fodder	A less organised subsistence system
FFD	'Normal' pit : striation ratio, total features and pit size	Graze or hay	An organised system, possibly with financial backing
FFE	High features Small pit size	Grains and chaff	A wealthy system providing cattle for a range of uses
FFF	Less features More larger pits	Browse fodder	A less organised subsistence system
FFG	Less features More larger pits	Browse fodder	A less organised subsistence system
FFH	'Normal' pit : striation ratio and total features, larger pit size	Graze or hay, some browse	An organised system under stress

Figure 7.11. Interpretation of microwear results

Summary interpretation of microwear results	*Flag Fen tooth specimens*	*Fengate tooth specimens*
A less organised subsistence system OR an organised system under stress	FFB, FFC, FFF, FFG	FNGA, FNGB, FNGF, FNGG, FNGJ, FNGL, FNGH
An organised, successful system	FFD	FNGD, FNGE, FNGH, FNGI, FNGN, FNGP
An organised, specialised system with financial backing OR a wealthy system providing cattle for a range of uses	FFE	FNGK, FNGM

Figure 7.12. Summary interpretation of microwear results

heavily on browse than that of FNGA, FNGB, FNGF, FNGG, FNGJ, FNGL and FFH, where there are indicators of dirty grass or hay foddering. FNGK, FNGM and FFE were foddered in systems able to support high-quality bucket food, while those in the preceding column were husbanded within a system able to provide good hay or graze.

The pattern of foddering practices around Flag Fen is of interest. Firstly, there is no indication of any difference in husbandry practices between Fengate and Northey 'island', apart from one browse cluster. Generally, the low numbers fed on browse reflect the highly organised enclosed landscape, in which more stressed subsistence activities would have been marginal, so it is interesting that the four with browse signatures are all from Flag Fen and are very closely clustered.

Overall, the pattern speaks of an organised system, operating more or less successfully, whose domestic concerns focus on cattle for food and for work. More successful management is characterised in summer by well-drained meadows or in winter by the supplementing of grass resources with hay. In contrast, signs of less successful management are, in winter or in waterlogged summer pastures, the infrequent provision of hay and fields that are likely to be overstocked and poached.

There were, however, a few animals fed on soft grains. As this feed was given immediately before death, it is unlikely that the cattle were intended for draught or other work. It is more probable that they were being brought to peak condition prior to trade, exchange or as food for feasting. The grain could have been a pre-sacrificial meal associated with ritual slaughter, as with the documented examples from the Bronze Age in Western Asia (Mainland and Halstead 2002) or akin to the evidence from the stomach contents of Iron Age bog-bodies (Coles *et al.* 1999).

The microwear signatures differentiate between final regimes and highlight the wide variety of uses for cattle. Oxygen isotope signatures can add evidence that may be used to infer social stratification relating to the interplay of cattle exchange as a part of elite networking with more parochial stock exchange associated with everyday animal husbandry. The five cattle teeth sampled for their $\delta^{18}O$ values show a variety of birth regions and droving patterns (Fig. 7.13, as suggested in Fig. 7.3).

In summary, FFG, FNGJ and FFE were all born in the autumn at Flag Fen. While FFG stayed there, the other two were droved inland and uphill at least for a season, before they returned to Flag Fen for their deaths. On the other hand, FFD and FNGG were born offsite during the spring; FFD was not droved down to Flag Fen until after its first year, but FNGG was moved nearer Flag Fen during its first year, although it did not reach there until later.

FFG was clearly locally raised, and FFD and FNGG droved-in from offsite, but the movement of FNGJ and FFE needs further thought. It is unlikely that these were members of reserve herds, belonging to a husbandry system that split its herds and sent some to pasture elsewhere. Firstly, the sheer distances involved are not those of single herd management. Secondly, the extensive field systems, supported by summer water-meadow pasturing and by nearby arable by-products, would have been unlikely to require this type of distance pasturing. Although not costly, droving is a time-consuming activity, not fitted to subsistence farming; it could be the case that, apart from FFG, all these animals were managed within a wealthier society where cattle exchange could take place either for economic or social purposes.

It is the synthesis of these two interpretations (as suggested in Fig. 7.4) that allows us to investigate any discrepancy between the two. The inferred life histories of these five cattle and their possible husbandry trajectories

Specimen	*Mean δ^{18}O (ingested water)*	*Range of δ^{18}O (ingested water)*	*Interpretation of watering regime in 1st year of life*	*Interpretation of region during 1st year of life*
FNG G Spring birth	-9.06	1.43	In first year moved south drinking progressively less depleted upland water	Outside Flag Fen, possibly Scottish eastern highlands.
FNG J Autumn birth	-8.72	1.89	Flag Fen water until early winter then continuing on depleted upland water	Born near Flag Fen then droved to (e.g.) the Peak District for at least a year
FFD Spring birth	-8.41	0.76	Raised in a year of equitable weather or watered from wells or large water bodies.	Outside Flag Fen, nearest region is the Peak District
FFE Autumn birth	-8.39	2.16	Flag Fen water until early winter then continuing on depleted upland water	Born near Flag Fen then droved to (e.g.) the Peak District for at least a year
FFG Autumn birth	-7.5	0.77	Raised in a year of equitable weather or watered from wells or large water bodies.	Within Flag Fen region

Figure 7.13. Interpretation of δ^{18}O results

Tooth sample	*Isotope interpretation*	*Microwear interpretation*	*Synthesis interpretation*
FFD	Born off-site, droved in before death	An organised, successful system	Exchanged for trade or breeding
FFE	Born nearby then droved elsewhere, then returned to Flag Fen	A wealty elite system	Brought on site for elite feasting or ritual offering
FFG	Born on site or nearby	A less organised subsistence system	Raised for settlement use
FNGG	Born off-site, droved in before death	An organised system under stress	Exchanged in trade or debt payment
FNGJ	Born nearby then droved elsewhere, then returned to Flag Fen	An organised system under stress	Exchanged in trade or debt payment

Figure 7.14. Synthesis of tooth microwear and δ^{18}O interpretations

(Fig. 7.14) immediately become clearer. FFG is the only animal locally born and bred. Despite dying in its prime it was given the fallback fodder of a struggling system before death. It would thus seem that husbandry at Flag Fen included subsistent activities not supported by arable integration or wealthier patronage. However, its remains were found at the fen-edge near the eastern limit of the post alignment on the Northey landfall, so the possibility of it being a modest votive offering despite its local origins and poor circumstances should not be excluded.

The other four animals spent at least some of their time away from Flag Fen. Only the final foddering of FFE and FFD suggest that droves were undertaken with more ambitious goals in mind. This is supported by the position of their remains near the post alignment. After at least a year living elsewhere, FFD was droved to the Flag Fen

basin over a distance possibly in excess of 150km, where it was fed on clean grass or hay before slaughter. As FFD was unlikely to be killed at the start of a potentially useful working life, its death as a young adult would suggest it was brought to Flag Fen deliberately to be used in a feast. This would seem to be the activity of an elite, or at least that of a successful herder integrated into a society that was organised and successful enough to provide good grazing or arable by-product back-up.

FFE is a little more complicated. Its final feed links it to a wealthy society able to offer a prime beast for feasting or votive offering. Its movement from Flag Fen to a place possibly 150km distant, followed by its return to Flag Fen for slaughter, suggests complexity of exchange, as well as the production of animals destined since birth purely to be a symbol of elite wealth, exchanged back and forth before being slaughtered for feasting or sacrifice.

FNGG and FNGJ were not found near the post alignment; neither did either of them die after eating very nutritious food. They were raised in a system which, although integrated enough for leafy fodder not to be required, could or did not provide hay. Either their position in society, or the wealth of society, forced them into more stressed husbandry practices. Yet both animals had histories of being droved; FNGJ in a complex to and fro of exchange (like FFE), and FNGG in a particularly long journey, at least from the north of England or east Scotland. As with FFE, these distances do not suggest economic trade or breeding exchange, both of which could have been managed within 50km of Flag Fen with far lower labour costs. However, as they both do indeed seem to be animals used in elite exchange, why do they end their lives on poor muddy grazing? The only explanation appears to be that the life histories of these animals are evidence for a downward spiral of exchanges by a wealthy owner increasingly unable to maintain original goals. Fortunes or alliances failed, initial plans gave way to more modest ones. Finally the beasts had to be exchanged on the economic market, ending their lives owned by modest farmers.

It suggests that there were economic relationships between different sections of society, possibly terminating in the Fengate cattle market stockyards. It also suggests we should take a more flexible view on the changing use and role of animals as they are moved through the landscape and from owner to owner and when they were used for both social and economic exchange; these two networks did not necessarily operate in separate realms.

The range of final uses for the four cattle brought to Flag Fen from off-site show that it would be unsafe to reconstruct similar histories for the other 17 cattle. However, the range of foddering practices should be noted: it suggests a landscape with poorer subsistence or economically stressed pastoralists living alongside those with greater wealth who were able to fodder their animals for optimum meat growth, working energy levels, or even for feasting or ritual.

Conclusion

In summary, the model presented in this paper has been able to throw light on some of the concerns of later Bronze Age herders; it also provides an insight into their relative economic and cultural integration within broader Bronze Age society. It confirms the importance of cattle in the later Bronze Age, and highlights the need for a contextual analysis of the material remains in order to understand the society's imperatives. It distinguishes different regional network and exchange systems, identifying the Flag Fen region as a centre of economic exchange, social feasting and ritual offering. It also suggests that elite exchange networks crossed and connected with economic ones, offering some support to Rowlands (1980).

The model has been tailored to the specifics of later Bronze Age society at Flag Fen, to cattle and to the Fenland palaeoenvironment and landscape. It could easily be recast to accommodate information pertaining to different herding societies. The main shortcomings lie not with the model, but in the limited pilot study, and are easily addressed.

8. Other Finds

Finds from excavations in 2005 along the western length of the post alignment

By Francis Pryor

Introduction

The assemblages described below came from four trial trenches (trenches 2005/1–4) across the western part of the post alignment (Fig. 2.2). The excavations are described here by Marcus Brittain in Chapter 2.

Pottery

The four trenches excavated in 2005 along the western length of the post alignment produced some 45 sherds of plain PD-R pottery weighing 344g (Fig. 8.1). Even though trench 2005/2 produced just one sherd, this is quite a substantial assemblage and suggests that pottery tends to occur more frequently as the Fengate fen-edge is approached. The fabrics all appear remarkably similar. Most were shell- and/or vegetable-tempered, although the shell has been dissolved by the acids in the peat. Many have a characteristic irregular pale exterior, suggesting that firing was far from even. The single sherd from trench 2005/2 was the only one that could be described as PD-R fineware; it was in a characteristic sandy fabric, but the finish was not as smooth as, for example, the small burnished omphalos-base bowl from Area 6B (Barrett 2001, Fig. 9.2, no. 7). Taken together, it is hard to avoid the conclusion that the assemblage represents very few vessels: possibly around three to six, but probably no more. This impression gains support from the four rimsherds shown in Figure 8.2. These all came from context 406 in trench 2005/4 and although their profiles seem superficially dissimilar, they are almost certainly from the same vessel, a bowl or jar about 100mm in diameter. A similar-sized complete bowl, also of varied profile, was found in Area 6B (Barrett 2001, Fig. 9.2, no. 6). Barrett considered this to have features (such as the finger impressions) in common with a local later variant of the general Deverel-Rimbury tradition of plain high-sided jars. A date around 1300 BC would be consistent with such an attribution for both vessels.

Although the pottery does not appear to be heavily abraded, its condition was quite soft and friable after exposure for so long in an acidic environment. It is hard to be certain, but it is tempting to suggest that many of these sherds could have come from a limited number of vessels that had been deliberately smashed, in the manner of much of the metalwork. It is also of some interest to note the absence of Iron Age pottery, given the proximity of the large Iron Age Cat's Water settlement.

Flint

There is not much that can usefully be said about so small an assemblage, but the two piercer/awls are characteristic of the later Bronze Age (Fig. 8.3).

Finds of pottery and flint from the Northey 'Green Wheel' excavations (1999)

By Francis Pryor

Introduction

The finds described below are from excavations described here by David Britchfield in Chapter 3. They represent a selection, the entire assemblage having been considered at greater length in the Green Wheel report (Pryor *et al.* 2001, 65–77).

Pottery

The excavations produced an important group of Beaker pottery which is described more fully below.

Catalogue of illustrated Beaker pottery (Figs 8.4 and 8.5)

1. Simple rimsherd of small bowl/jar. Ext. decoration of slashed, rough inter-cutting herringbone or informal chevrons. From small pit F25 (context 66; cut 65), trench NT1. Beaker.

2005 Description of identifiable sherds (ordered by context)	*No. sherds*	*Weight (gm)*	*Date*	*Finds No.*	*Context*	*Notes*
Trench 1						
Plain bodysherds, medium-sized vessel; dark fabric with many vacuoles	*5*	*36*	*PD-R*	*1*	*104*	
Plain bodysherds, small vessel; dark fabric with many vacuoles	2	10	PD-R	2	104	
Plain bodysherd, small vessel; dark fabric with many vacuoles	1	11	PD-R	3	104	
Plain bodysherd, small vessel; dark fabric with many vacuoles	1	5	PD-R	4	104	
Plain bodysherds, medium-sized vessel; dark fabric with many vacuoles	6	23	PD-R	5	104	
Plain bodysherd, small vessel; dark fabric with many vacuoles	1	4	PD-R	6	104	
Plain bodysherds, medium-sized vessel; dark fabric with many vacuoles	7	30	PD-R	10	104	
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	11	PD-R	20	105	Found next to V0036
Trench total:	**24**	**130**				
Trench 2						
Plain bodysherds, small vessel; dark, finer sandy fabric than trench 1	2	16	PD-R	61	210	
Trench total:	**2**	**16**				
Trench 3						
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	23	PD-R	120	peat	
Plain bodysherd, pale exterior; dark fabric with many vacuoles	1	6	PD-R	121	peat	
Plain bodysherd; dark, friable fabric with many vacuoles	1	2	PD-R	122	peat	
Plain bodysherd; dark, friable fabric with many vacuoles	1	7	PD-R	123	peat	
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	10	PD-R	124	peat	
Plain bodysherd; dark fabric with many vacuoles	1	2	PD-R	125	peat	
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	21	PD-R	132	peat	
Trench total:	**7**	**71**				
Trench 4						
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	33	PD-R	41	10	
Plain bodysherd; dark fabric with many vacuoles	1	5	PD-R	43	10	
Plain bodysherd; dark fabric with many vacuoles	1	2	PD-R	46	11	
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	7	PD-R	47	411	
Rimsherd (simple) of plain bowl/jar; diam ca. 100 mm	1	14	PD-R	50	411	One of 4 sherds from same vessel?
Plain bodysherd; dark fabric with many vacuoles	1	6	PD-R	52	411	
Neck (near rim) of plain bowl/jar; possibly same vessel as Pot 50	1	12	PD-R	57	411	One of 4 sherds from same vessel?
Plain bodysherd; dark fabric with many vacuoles	1	5	PD-R	58	411	
Rimsherd (simple) of plain bowl/jar; diam ca. 100 mm	1	11	PD-R	60	411	One of 4 sherds from same vessel?
Plain bodysherd; dark fabric, pale ext. with many vacuoles	1	3	PD-R	100	peat	
Plain bodysherd, medium-sized vessel; dark fabric with many vacuoles	1	15	PD-R	103	peat	
Rimsherd (simple) of plain bowl/jar; diam ca. 100 mm	1	14	PD-R	104	peat	One of 4 sherds from same vessel?
Trench total:	**12**	**127**				
Grand total:	**45**	**344**				

Figure 8.1. Pottery from 2005 excavations

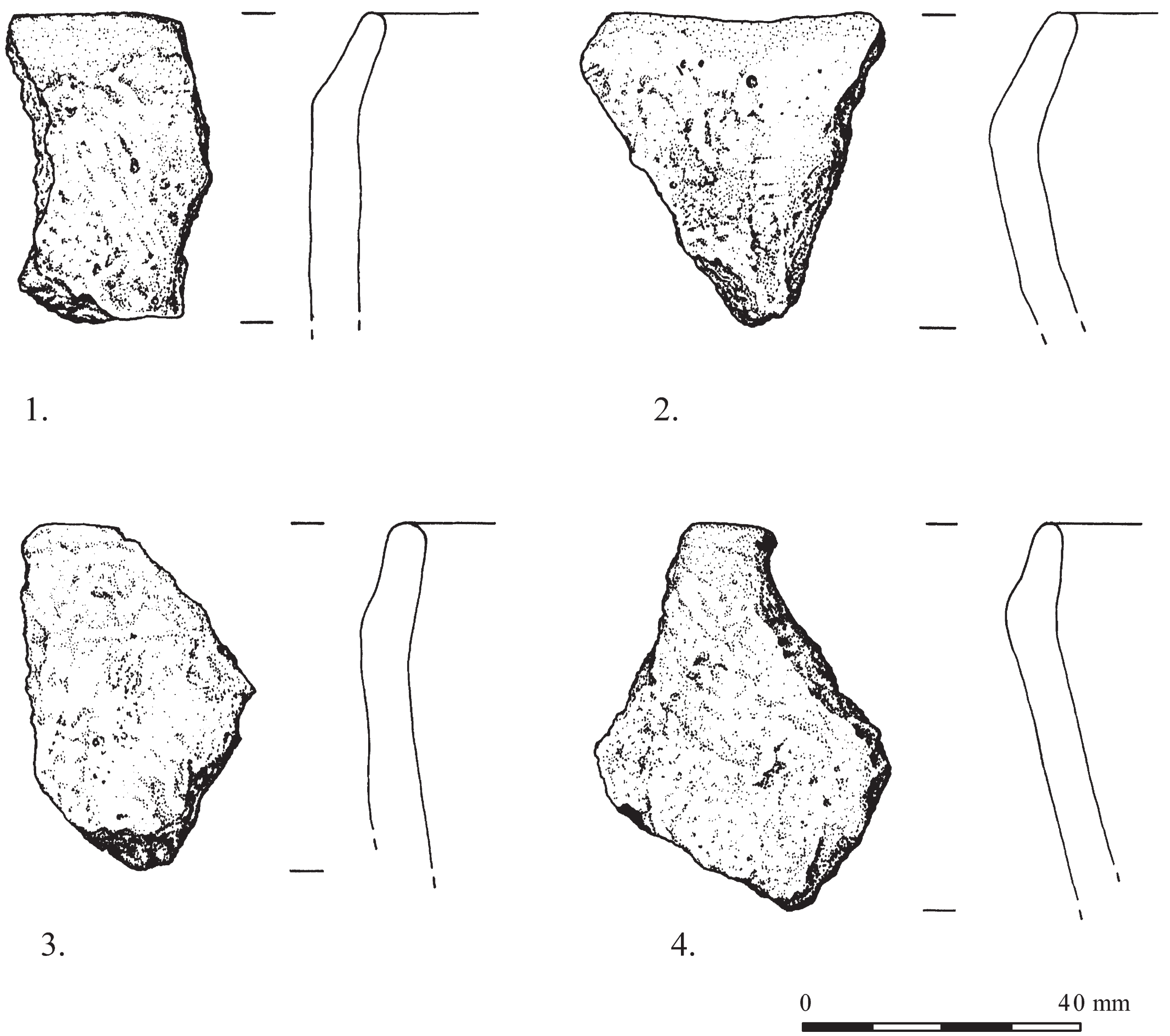


Figure 8.2. These four sherds from the western post alignment (trench 2005/4), are probably from the same vessel and are illustrated to show their variability. 1, small find 60; 2, small find 50; 3,small find 57; 4, small find 104

2005 Description of flints (ordered by context)	*By-products*	*Implements*	*Date*	*Finds No.*	*Trench*	*Context*
Utilised flake		1	Neo/BA	62	2	213
Retouched and utilised flake		1	BA	135	3	
Piercer/awl with single point		1	LBA/IA	131	3	peat
Waste flake	1		Neo/BA	110	4	
Utilised flake		1	Neo/BA	106	4	
Piercer/awl with single point		1	LBA/IA	42	4	10
Total implements and by-products	1	5				
Total flints	6					

Figure 8.3. Flints from 2005 excavations

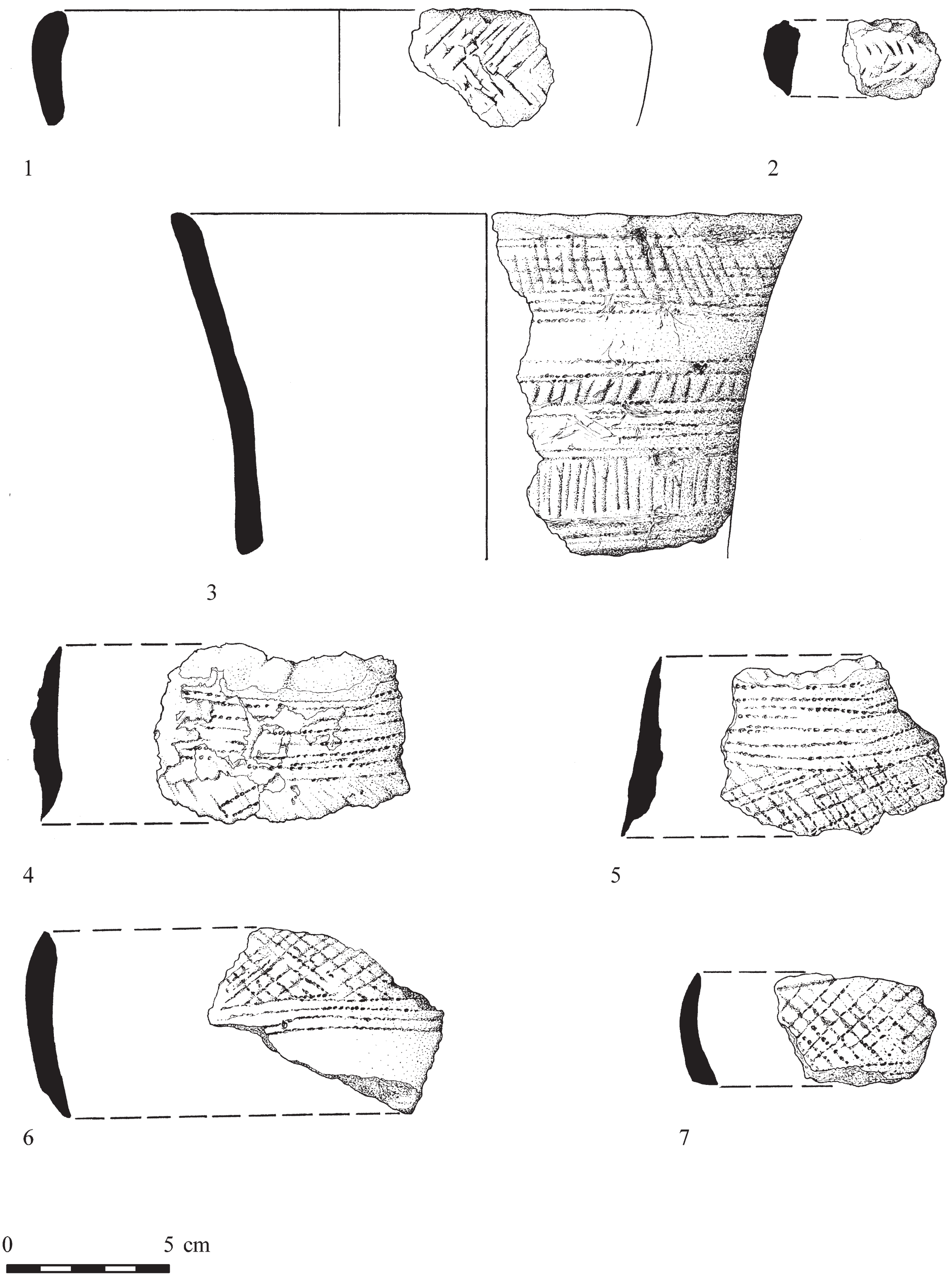


Figure 8.4. Beaker pottery from the Green Wheel excavations

2. Bodysherd with three rows of diagonal impressions (herringbone) separated by reserved bands. Very slight indications that impressions made with ridged/toothed implement (*Cardium*-type shell?). From small pit F26 (context 72; cut 71), trench NT1. Beaker.

3–7. One rimsherd and upper part of body; four sherds from lower part of body. Decoration of toothed comb-impressions arranged in horizontal filled and reserved zones. Exterior surface pale buff/brown, interior reduced. From small pit F69 (context 432; cut 431), trench NT2. Beaker, Vessel A (see text).

8. Rimsherd. Decoration of toothed comb-impressions

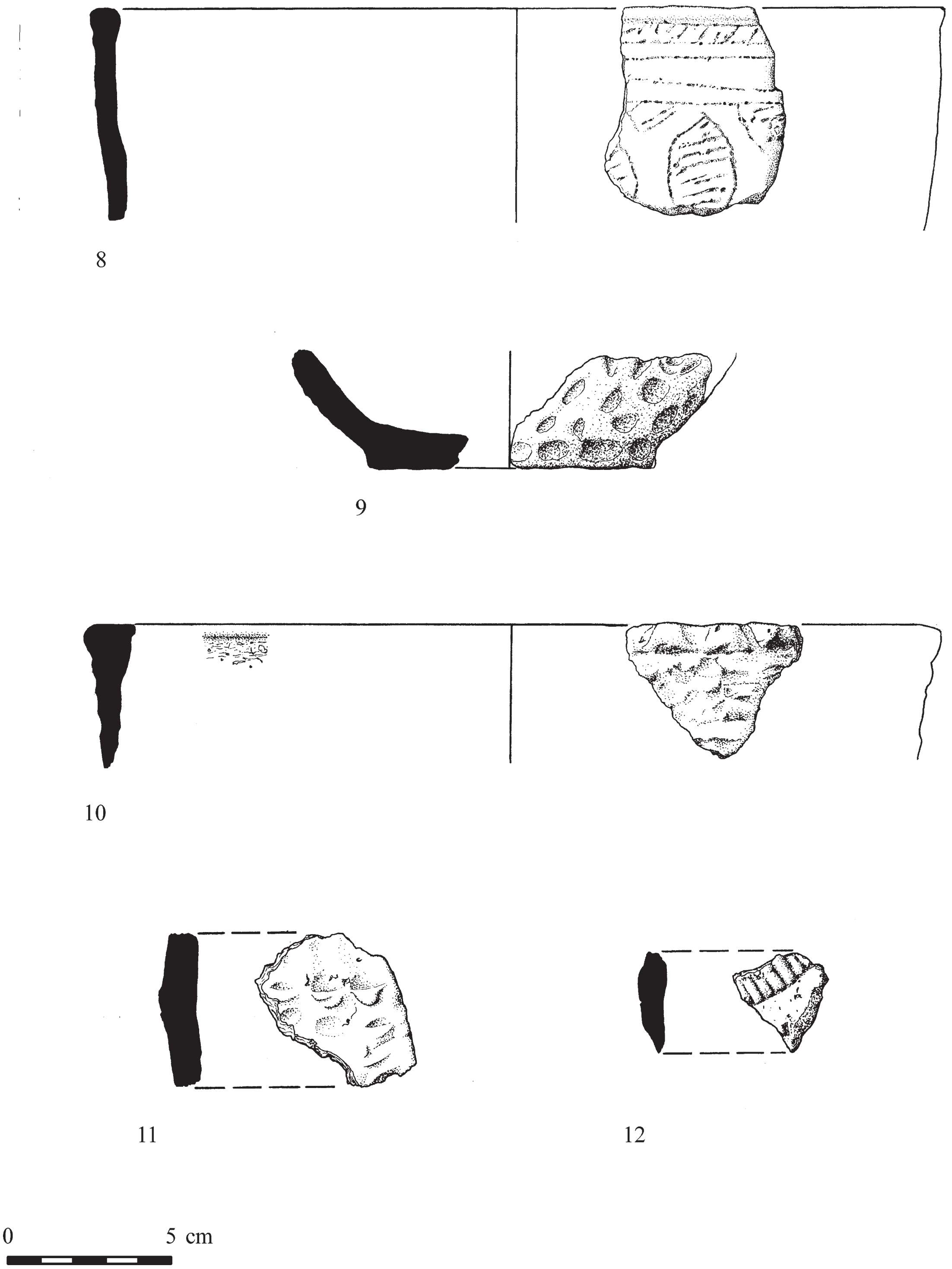


Figure 8.5. Beaker pottery from the Green Wheel excavations

arranged in both vertical and horizontal filled and reserved zones. Exterior surface pale buff/brown, interior reduced, but paler than Vessel A (above). From small pit F69 (context 432; cut 431), trench NT2. Beaker, Vessel B (see text).

9. Basesherd and lower part of body. Rusticated decoration of finger-tipping in rough horizontal rows. Exterior surface pale buff/brown, interior reduced. From small pit F69 (context 432; cut 431), trench NT2. Beaker, Vessel C (see text).

10. Rimsherd. Rusticated decoration of finger-tipping around rim and in rough horizontal rows on body.

Exterior surface pale buff/brown, interior reduced. From a small pit (context 512; cut 511), trench NT2. Beaker, Vessel D (see text).

11. Bodysherd. Rusticated decoration of finger-tipping in rough horizontal rows on body. Exterior surface pale buff/brown, interior reduced. From small pit (context 512; cut 511), trench NT2. Beaker, Vessel D (see text).
12. Bodysherd. Zonal comb-impressed decoration similar to, but slightly cruder than, that on Vessel B (above). Exterior surface pale buff/brown, interior reduced. From small pit (context 512; cut 511), trench NT2. Beaker, Vessel D (see text).

Discussion

Northey has revealed a fine assemblage of Beaker pottery which has added significantly to the already large repertoire of material found in the Flag Fen basin. The reader's attention is particularly drawn to the published catalogue of domestic Beaker pottery from Fengate in Peterborough Museum (Gibson 1982, 383–99). References to Beaker finds in the four Fengate reports are given in Pryor 1984 (256–7).

Two of the small pits in trench NT2 contained relatively large quantities of unabraded pottery with several conjoining pieces. Five vessels (A–E) could be identified with some confidence and there were no sherds that could not be attributed to a particular vessel. This would suggest that the material derived from a specific source and did not include a substantial element of domestic debris. It might also indicate that the material had been deliberately broken and then placed in the ground, perhaps for ritual reasons. The comb-impressed decoration of Vessel A is generally well executed and the pot itself is well made and fired. Although not of the very first quality (*cf.* Barnack: Donaldson *et al.* 1977), it is nonetheless the sort of vessel one might traditionally have expected from a grave. Recently the simple distinction between Beakers intended for burial and so-called domestic Beakers has been shown to be far more complex (Boast 1995). Vessel A and its unusual circumstances of deposition is clearly a case in point.

The non-comb-impressed Beaker wares include vessels with finger-tip and pinched rustication. This is a style of decoration commonly encountered along the Fen margins, at Fengate and farther afield, at sites such as Fifty Farm and Hockwold-cum-Wilton (Gibson 1982).

Turning to later Bronze Age material, 32 sherds from a globular storage jar were found in a shallow pit (F260) in trench NT4. The fabric is Late Bronze Age and has many parallels in PD-R assemblages at sites such as Welland Bank Quarry (Pryor 1998b). The simple rim and lightly fingertip-impressed girth are also typical of later Bronze Age wares. Comparisons may be drawn outside our area, with, for example, Jar Types 51 and 31 from Potterne, Wiltshire (Lawson 2000, 164, 171).

Pottery of probable Early Iron Age date was confined to a spread of redeposited gravel (which perhaps formed a made-up floor) which sealed the posts of the post alignment in trench NT2. 22 sherds were recovered; most of these probably came from the same vessel, suggesting that the material was indeed *in situ* and was not derived from residual sources. The fabric was rich in grog, which is unusual in the area. It is harder and better fired than most PD-R later Bronze Age fabrics and does not include crushed fossil shell, which is almost universal in middle and later Iron Age wares at Fengate. The rimtop decoration – pinched fingernail – is typical of both Late Bronze Age and Early Iron Age traditions and the row of perforations below the rim is most unusual. Taken together the evidence would tend to favour an Early Iron Age date for this pottery.

Finally, 13 sherds of a wheel-made carinated bowl or jar were found in desiccated peats in Test Pit 11, trench NT1. The form and fabric of this vessel is very similar to many examples from the nearby Cat's Water Iron Age settlement at Fengate (Pryor 1984, 133–76).

Flint

Introduction

Northey excavations produced 143 worked flints, of which 48.95% were implements (Fig. 8.6). The vast majority of implements were essentially of Bronze Age type, but there was also a significant (probably early) Neolithic component, which included two long-end scrapers and a scraper on a

	Frequency	*% of total*
Implements		
Long end-scraper (Ai)	8	5.59
Short end-scraper (Aii)	3	2.1
Short side-scraper (Dii)	2	1.4
Scraper on broken flake (E)	1	0.7
Serrated flakes (whole)	3	2.1
Serrated flakes (broken)	1	0.7
Utilised flake (whole)	19	13.29
Utilised flake (broken)	7	4.9
Retouched flake (broken)	1	0.7
Denticulates	14	9.79
Piercers	5	3.5
Bifacially retouched implement	1	0.7
Polished axe fragment	1	0.7
Utilised irregular workshop waste	4	2.8
Sub-total:	70	48.95
By-products		
Core, single platform (Aii)	1	0.7
Core, two platforms (Bii)	1	0.7
Waste flakes (whole)	24	16.78
Waste flakes (broken)	14	9.79
Irregular workshop waste	23	16.08
Tiny spalls	9	6.29
Core rejuvenation flake	1	0.7
Sub-total	73	51.05
Total	143	100

Figure 8.6. Flints from Northey excavations

broken flake; two short side-scrapers may also be Neolithic. Retouch was generally steep (*cf.* Pryor 1974, fig. 7, 25–7). Other probable Neolithic implements included four serrated flakes, one of which had clear diffuse lustre on the ventral surface cutting edge, and a fragment of a probable polished flint axe. In this case the axe itself was probably Neolithic, while the breakage could have happened later, perhaps even in the Bronze Age.

A high proportion (16) of the total (26) utilised flakes derived from the buried soil and it is quite possible that the scars that provide the evidence for use in fact resulted from ploughing or some other post-depositional factor. Denticulates and piercers were the next most commonly found group of implements. These later Bronze Age or even Iron Age implements closely resemble those found in Bronze Age contexts at Fengate (*e.g.*, Pryor 1980, 118–21). They were often made using a type of 'pseudo-core' technique, in which deep flakes were detached from an informal striking platform to give a series of sharp scalloped facets, many of which bore clear signs of use. The technique was somewhat hit-and-miss, and many circular points of impact, where flakes had failed to detach, could be seen near the edge of striking platforms.

By-products

Two cores were identified, but these might also be seen as core-like denticulates or 'pseudo-cores'. Small spalls provided evidence that some of the knapping took place in the immediate vicinity and there was much irregular workshop waste that was the result of a conventional core or blade-based technology. This material is most probably a by-product of the production of 'bashed' denticulates and piercers and as such probably dates to the later Bronze Age.

The assemblage of 43 complete flakes was just large enough to provide a statistically significant sample (Pryor *et al.* 2001, table 2.4). The histogram of breadth:length ratios shows a bi-modal tendency which suggests the presence of two traditions on site: one earlier and blade-based; the other later, producing less controlled, shorter, squatter flakes.

Discussion

The ratio of implements to by-products (70:73) and the general rarity of struck flint suggests that knapping did not take place at anything remotely approaching an 'industrial' scale. The gravel subsoil includes rolled flint pebbles and these would have occurred from time to time on the surface. Even so, this readily available source of raw material does not seem to have been systematically exploited. Instead, the impression given is of small-scale working of gravel pebbles as and when needed; this may have been supplemented by the reworking of earlier implements found in the area, or perhaps brought to the site. Sometimes gravel pebbles were struck to provide a cutting edge or sharp denticulate point that was probably then used to work hide and bone (Pryor 1980).

We have noted that the flake length:breadth ratios showed a distinctly bi-modal distribution which indicates that two traditions were represented at the Northey landfall: an earlier, probably Neolithic blade-based industry and a later, mainly Bronze Age tradition which used shorter, squatter flakes. When we compare the different contexts that have yielded flakes and blades, however, there is no distinctive difference. Put another way, the bi-modal distribution cannot be attributed to a single cause such as a prolonged period when the site was abandoned. Rather, it suggests a relatively homogeneously distributed background 'noise' of residual Neolithic material that persists into Bronze and Iron Age times.

The later technology was not based on the conventional flake and core technique alone, but instead used direct percussion to produce irregularly shaped implements with sharp points and denticulated facets. This technology seems to have developed during the latter part of the Early Bronze Age and is widely distributed in the area by the mid-2nd millennium BC (*cf.* Pryor 1980, 106–25). The Northey evidence seems to indicate that this technique may have had its origins within the Beaker tradition, early in the Bronze Age.

Finds from the Northey landfall excavations 2003/1–2 and 2004/3

By Francis Pryor

Introduction

The material discussed here was found in trenches 2003/1 and 2003/2 (Fig. 3.6) of the post alignment's Northey landfall, which were excavated during the summers of 2003 and 2004. The trenches are discussed here by David Britchfield in Chapter 3.

Pottery

The pottery from trenches 2003/1 and 2003/2 was, generally speaking, in poor condition and many of the sherds were quite highly eroded (Fig. 8.7). No sherds could reliably be conjoined along ancient breaks. The vast majority of the material was in the Middle Iron Age 'scored ware' tradition found at Fengate and at many other sites in the east Midlands. A broad date of around 350–250 BC, or slightly earlier, seems to be indicated. There was also evidence for some PD-R material from a stake-hole (F315) in trench 2003/2 and from the buried soil (Horizon VII), though the material from Horizon VII was weathered and probably residual. Three Iron Age scored ware rimsherds from the watering hole F292, which were decorated with fingernail impressions, were undoubtedly from the same vessel. This would indicate that this particular assemblage was a reliably closed group, possibly from a dumped back-filled deposit, where residual material would not be expected.

Perhaps surprisingly, trench 2004/3 – essentially an extension of trench 2003/1 – did not reveal any PD-R

Description of identifiable sherds (ordered by context)	No. sherds	Date	Finds No.	Trench	Context	Feature	Horizon	Notes
2003								
Body and base angle of large vessel, with scored ext. decoration. Fengate fabric 1A.	1	MIA		1	97		VII	Buried soil
Small bodysherd. Fengate fabric 1A/B.	1	IA?		1	151		VII	Buried soil
Small bodysherd. Fengate fabric 1A/B.	1	IA?		1	159		V	Buried soil
Fineware bodysherd of small necked bowl/jar. Fabric with fine sand and ground shell. Probably PD-R	1	PD-R		1	175		VII	Buried soil
Small bodysherd of shouldered vessel. Fengate fabric 1A	1	MIA		1	195 (was 381)	F292		Water-hole
Bodysherd with base angle. Scored decoration on exterior. Fresh. Fengate fabric 1A.	1	MIA	36	1	196	F292		Water-hole
Three small rimsherds in reduced fabric 1A. FN decoration on flattened top. From small bowl/jar (dia. c. 50mm).	3	MIA		1	195 (was 642)	F292		Dumped gravel deposit in water-hole
Cordoned body sherd, possibly from same vessel as above.	1	MIA		1	195 (was 642)	F292		Dumped gravel deposit in water-hole
13 bodysherds, possibly from 2-3 vessels. Fengate fabrics 1A and 1B.	13	MIA		1	195 (was 642)	F292		Dumped gravel deposit in water-hole
Six bodysherds and c.10 scraps from small necked bowl/jar in friable Fengate Fabric 1A. Probably PD-R.	1	PD-R?		2	274	F315		Stake hole
Bodysherd of small bowl/jar with FN impressions on cordon. Weathered. Fengate Fabric 1A.	1	EIA		1	605		V	Lower buried soil
Four bodysherds of plain medium-sized vessel(s). Weathered. Fengate Fabric 1A/B	4	IA		1	641		VII	Buried soil
Rim and upper body of small (dia. c. 50mm) globular bowl/jar. Rim beaded scoring below neck. Fengate Fabric 1A.	1	MIA	85	2	714		Mod	
2004								
Small bodysherd. Fengate fabric 1A/B.	1	?IA	307	3	805		VII	Buried soil
Rim and upper body of small necked bowl/jar. Simple rim, finger marks on neck. Residue on exterior. Fengate Fabric 1A.	1	MIA	89	4	746		VII	Buried soil
Total sherds	32							

Figure 8.7. Pottery from 2003 and 2004 excavations

Description of flints (ordered by context)	*By-products*	*Implements*	*Date*	*Finds No.*	*Trench*	*Context*	*Feature*	*Horizon*	*Notes*
2003									
1 flake	1		B/IA?		1	19		VII	Upper buried soil
1 flake and 1 bashed denticulate/piercer	1	1	B/IA?	28 & 29	1	40		VII	Upper buried soil
1 utilised flake		2	B/IA?		2	52			Buried soil?
1 utilised flake		1	B/IA?		1	53		VII	Upper buried soil
1 flake	1		B/IA?		1	54		VII	Upper buried soil
3 flakes and 1 irreg. workshop waste	4		B/IA?		1	55		VII	Upper buried soil
1 flake and 3 irreg. workshop waste	4		B/IA?		1	66		VII	Upper buried soil
1 flake and 1 irreg. workshop waste	2		B/IA?		1	90		VII	Buried soil
1 fabricator (? Neo, residual?); 2 irreg. workshop waste; 1 flake	3	1	B/IA?		1	128		VII	Buried soil
3 flakes; 1 utilised flake	3	1	B/IA?		1	148		VII	Upper buried soil
3 flakes and 3 irreg. workshop waste	6		B/IA?		1	150		VII	Upper buried soil
1 flake	1		B/IA?		1	151		VII	Upper buried soil
2 flakes	2		B/IA?		1	155		VII	Upper buried soil
1 flake	1		B/IA?		1	157		VII	Upper buried soil
1 irreg. workshop waste	1		B/IA?			161		VII	Lower buried soil
1 irreg. workshop waste	1		B/IA?		1	163		VII	Upper buried soil
2 flakes	1		B/IA?		1	164		UBS	Upper buried soil
1 flake	1		B/IA?	69	1	170		VII	Gravel capping on upper buried soil
1 disc scraper		1	EBA	31	1	177		VII	Upper buried soil
1 flake	1		B/IA?	68	1	195 (was 354)	F292		Water-hole
1 flake; 1 retouched flake	1	1	B/IA?	58 and 54	1	195 (was 381)	F292		Water-hole
3 flakes	3		B/IA?		2	273	F315		Stake hole
1 flake	1		B/IA?			557		VII	Upper buried soil
1 flake	1		B/IA?			559		VII	Upper buried soil
1 utilised flake		1	B/IA?			560		VII	Upper buried soil
2004									
1 short end-scraper with flat retouch		1	EBA	175	3	749		VII	Upper buried soil
1 (?) utilised irreg. workshop waste	1		B/IA?	171	3	749		VII	Upper buried soil
1 (?) utilised irreg. workshop waste	1		B/IA?	148	3	749		VII	Upper buried soil
1 pebble core	1		B/IA?	104	3	749		VII	Upper buried soil
1 scraper on a thermal flake		1	B/IA?	176	3	749		VII	Upper buried soil
1 irreg. workshop waste	1		B/IA?	174	3	749		VII	Upper buried soil
1 much worn denticulate/piercer on gravel pebble		1	B/IA?		3	755		IV	Lowest redeposited gravel (I)
1 (?) utilised primary flake	1		B/IA?	231	3	755		IV	Lowest redeposited gravel (I)
1 (?) utilised tertiary flake	1		B/IA?	237	3	777		VII	Upper buried soil
1 much worn denticulate/piercer on gravel pebble		1	B/IA?	211	3	794		VII	Upper buried soil
1 irreg. workshop waste	1		B/IA?	263	3	813		VII	Upper buried soil
1 irreg. workshop waste	1		B/IA?	302	3	820		VII	Upper buried soil
1 utilised flake	1		B/IA?	368	3	825		VII	Middle redeposited gravel (II)
1 irreg. workshop waste	1		B/IA?	425	3	828		V	Lower buried soil
1 broken retouched and utilised flake		1	EBA	397	3	834		V	Lower buried soil
Total implements and by-products	50	14							
Total flints	64								

Figure 8.8. Flints from 2003 and 2004 excavations

pottery. Indeed, there were few diagnostic pieces other than the rim and shoulder of a necked bowl or jar in a black reduced fabric with large pieces of fossil shell as inclusions. This is without much doubt a Middle Iron Age piece. The few other plain bodysherds are in similar fabrics and are probably of broadly similar date. This might suggest that the buried soil of Horizon VII took rather longer to form than its thickness might lead one to expect, or that the PD-R sherds found in it during the 2003 excavations were, in fact, residual.

Flint

The 64 pieces of flint consisted of 50 by-products and 14 implements (Fig. 8.8). This ratio would indicate that flint-working was taking place in the immediate vicinity. The flint used was sourced from the local gravels and the assemblage, taken as a whole, would be considered 'late'. In other words, blades were entirely absent and most of the flakes showed a marked lack of control: many were side-struck, while many also showed evidence for hinge-fracture. In addition, there was a high proportion of irregular workshop waste. There were only three diagnostic artefacts: a unifacially retouched and utilised fabricator fashioned on a blade-like flake, which is most probably residual (later Neolithic or Early Bronze Age); and two well-executed scrapers with flat retouch, of Early Bronze Age date. Again, these would probably have been residual. The other possible implements consisted of utilised flakes, irregular workshop waste and two roughly made denticulated tools. These few items aside, the rest of the assemblage would fit comfortably with the pottery, which was entirely of later Bronze and Iron Age date. Although a degree of residuality cannot be ruled out, the flakes from the watering hole (F292) in trench 2003/1 were sharp and fresh, which would suggest that flint-working was probably still taking place as late as the Middle Iron Age (F292 produced sherds of Iron Age scored wares).

Worked stone

By David Buckley, with geological identifications by Lys Drewett

Context

Two small pieces of worked stone were recovered from trench 2003/1; these came from buried soil horizon VII (Chapter 3, this volume). The stones were found in close proximity to a Middle Bronze Age watering hole (F292), which formed part of a field system bordering the eastern extent of the Flag Fen basin.

Quern fragment

The first of these pieces of stone was a fragment weighing 64g and measuring a maximum of 600×450mm. It was too small for the original dimensions to be determined, but retained a small area of flat surface interpreted as being part of the grinding surface of a former saddle quern. The stone is a dark grey to black Greywacke sandstone deriving from Palaeozoic deposits, such as those that occur in the southern uplands of Scotland, and is likely to have reached the Flag Fen area as a part of the process of glacial deposition.

This small fragment of saddle quern enables little to be added to the discussion about saddle quern dating, sources of stone and circumstances of deposition which resulted from the four saddle quern lower stones excavated from beneath the nearby Flag Fen post alignment (Buckley and Ingle 2001, 322–9). The special circumstances of deposition, completeness and limited use of these four stones merited greater comment than had formerly been made for many of the saddle quern fragments found in contexts at numerous prehistoric sites. Now that they are receiving greater attention there is a growing body of evidence which indicates that saddle querns passed through networks of exchange and that social considerations, above and beyond strictly utilitarian factors, influenced their distribution (Heslop 2008, 17). Even small fragments of saddle quern have been recognised as the result of breakage to symbolically 'kill' the object, possibly upon the death of the owner, followed by ritual deposition (Brück 2001, 152). Flag Fen does not sit in isolation and many of the objects found in this ritual wetland context would also be expected in the surrounding domestic landscape. While this fragment was found in close proximity to the area of the Flag Fen ritual landscape it came from a buried soil horizon and there appear to be no special circumstances relating to its deposition. The finding of the fragment in a buried soil horizon containing Middle Bronze Age and some Iron Age finds does not preclude an earlier date; saddle querns appeared during the Neolithic and continued in use into the Roman period.

Figure 8.9. Perforated stone from buried soil horizon VII.

Perforated stone

The second piece of stone was part of a formerly elongated pebble; it weighed 44g and its remaining dimensions were 400mm on the original long axis, 400mm in width and 250mm in maximum thickness. It is Arkose, a light-coloured sedimentary sandstone, and is very well weathered, water worn and most likely to be a glacially deposited pebble (Fig. 8.9).

The stone is broken across the middle of an hour-glass-shaped perforation which has a diameter of *c.*200mm at each of the surfaces, reducing to *c.*4mm at the constriction. It is typical of the shape achieved with a bow drill, although a number of faint downwards striations on one of the bevelled surfaces points to some additional working to achieve the shape. At the junction point of the hour-glass-shaped perforation, on the broken section the surface is rough, indicating that the two perforations did not quite meet in the middle. Either the perforation was slightly offset or it is possible that the process was not completed and that the stone broke during manufacture. The outer faces of the pebble are natural but one face is generally flat and smooth, possibly indicating that it was used as a small whetstone, although this is inconclusive. There are recorded examples of perforated whetstones from Bronze Age contexts, but they are usually much better shaped than this object. This also applies to the other forms of perforated stone object found in contexts throughout the Mesolithic to Iron Age periods which are variously interpreted as mace heads, spindle whorls, small weights and pendants. The reason for putting a lot of time and effort into perforating an ordinary-looking pebble is not known; in an early study of drilled hour-glass-perforated pebbles and cupped pebbles from Mesolithic contexts it was noted that many had no evidence for use and that they might have a ritual connection (Rankine 1956, appendix C).

Although buried soil horizon VII (see Chapter 3, this volume), from which this perforated stone came, has Middle Bronze Age finds, there is no specific evidence that the stone is of this date and it could be earlier.

Human skeletal remains

By Lavinia Ferrante di Ruffano

Introduction

This report details the observations on the skeletal remains recovered from the Northey landfall at the northern side of the Flag Fen trackway between 2003 and 2004 (Fig. 3.6).

Methods

The degree of sexual dimorphism is not equal in all skeletal elements and is presented most strongly in the cranium and pelvis. Owing to an absence of pelves here, biological sex was determined using the secondary sexual characteristics of the cranium. In males the onset of puberty is initially marked by an increase in the production of the hormone testosterone, which stimulates an acceleration in the growth of muscle mass and a corresponding increase in skeletal mass at muscle attachment sites (Mays and Cox 2000). This is evident primarily in the skull, where growth of the neck and masticatory muscles serve to elongate the face and enlarge the mental eminence, mastoid processes, nuchal crest and supraorbital ridges, as well as accentuating the temporal and nuchal lines. Conversely, the typical mature female skull is more gracile, retaining smoother and smaller attachments sites. Obviously, as the observed differences rely on muscle mass, robust females will display more masculine features.

Age at death was estimated from the degree of epiphyseal fusion for immature bone and the degree of obliteration of cranial sutures in mature individuals. Epiphyseal fusion was charted using the data compiled by Buikstra and Ubelaker (1994) and White (2000, based on data from McKern and Stewart 1957). It is worth mentioning briefly that these charts are based on data from modern or recent juvenile populations, which differ greatly in nutritional, economic and social status from the archaeological population under study.

Once skeletal maturation is complete, age can be estimated only from degenerative changes known to occur with increasing age. These deductions are far more problematic, as progressive morphological degeneration is neither constant nor caused solely by ageing, and is subject to considerable individual variation. For example, the Spitalfields controlled experiment, in which individuals of known age at death were assessed using a range of osteological methods, found that only 39% of adults were placed into the correct age range (Molleson and Cox, 1993). While the cranial suture method was found to be the least successful of all methods investigated at Spitalfields (Key *et al.* 1994), it is the only age indicator that has been preserved in the current assemblage and hence has been used as a general indicator of adulthood.

Since measurements require an excellent degree of completion, none could be taken in this collection, and consequently stature, too, could not be estimated. Owing to the incomplete state of the recovered elements, systematic analysis was limited to anatomical identification and examination for pathological change.

Results

Nature of the assemblage

Eight fragments of human bone were retrieved, two of which were identified as human during the post-excavation analysis of animal bone (FF03–642 from watering hole F292 and FF04–749 from the upper buried soil horizon VII). The remaining six fragments were found in close proximity to each other in the 2003/1 trench within the upper buried soil horizon VII. Five of these were cranial fragments that upon reconstruction were found to belong to the partial cranium of a single individual (SF230, SF264, SF271,

Figure 8.10. Reconstructed partial cranium

SF275, SF283) (Fig. 8.10). Elements were identified and recorded as catalogued in Figure 8.11.

The assemblage contains the remains of at least two individuals, as identified by discrepant age-at-death characteristics; the humeral shaft (FF03–642) was clearly that of an older subadult, while the partial cranial vault was that of an adult individual (see below). Watering hole F292 has been assigned a Middle Iron Age date (Pryor, this chapter) based on the pottery fragments recovered from its fills. However, material dating from the Neolithic, Bronze Age and Iron Age has been recovered from the upper buried soil horizon VII.

Preservation and taphonomy

Generally, preservation was good. While no complete elements were found, each fragment is solid, with little damage to the external cortex. All eight fragments represent large long bones or robust areas of the skull; therefore, this assemblage shows the usual biased survival of heavier, denser elements.

Seven of the eight fragments, including the partial cranium, unidentified shaft fragment and femur shaft, had well-rounded edges and demonstrated rounding-off of bony projections (muscle markings and fragmented ends of shaft), which is typical of abrasion by current-driven, sediment-laden water. The rounding was even present on the edges of adjoining cranial fragments, suggesting that they had been fractured for some time. However, the lack of dissolution (corrosive pitting of the bone surface) suggests a low salinity environment (Haglund *et al.* 2001).

Age

Five fragments displayed characteristics from which age at death could be estimated, albeit very broadly. The humeral shaft FF03–642 includes a small section of the distal lateral metaphysis that displays an area of billowing (regular 'ridge and furrow' undulations of the bone surface), which is typical of the immature, unfused surface. Fusion of the distal epiphysis is observed to begin at approximately 11 years and is generally complete by 15 years of age. Four of the five cranial fragments contained sections of the coronal and sagittal sutures, all of which were partially obliterated externally, indicating that the individual was almost certainly an adult (≥18 years of age). The slight osteophytic growth along the right temporal line (SF271) and the near-total obliteration of all extant endocranial sutures may further suggest an adult of later age; however, this remains conjecture.

Sex

Determination of sex could be attempted for two fragments, both belonging to the partial cranial vault. The robust, bulbous supraorbital ridge (SF271 and SF283) and thick eye orbit margin (SF283) were both strongly masculine characteristics. While such craniofacial features are not as accurately representative of biological sex as those of the pelvis, the degree of robusticity in these two fragments is convincingly indicative of male sex.

Pathology

All fractures observed were post-depositional in origin. A single pathological lesion, located on the parietal and frontal fragment (SF264), was identified. The smooth sub-rounded protrusion of cortical bone is suggestive of an osteoid osteoma ('button' osteoma) measuring 14mm antero-posteriorly by 9mm medio-laterally.

Benign and generally asymptomatic osteoid osteomas

Site	*Provenance*	*Context*	*Element*	*Side*	*Age*	*Sex*	*Pathology*	*Preservation*	*Comments*
FF03	Watering Hole F292	642	Humeral Diaphysis including the partial lateral epicondyle.	Left	11-15	Unknown	None	Good	Lateral epicondyle is unfused.
FF04	Upper buried soil VII	749	Femoral Diaphysis	Right	Unknown	Unknown	None	Good. Smoothed taphonomic changes to bone surface consistent with abrasion by current-driven, sediment-laden water.	SF373. Epiphyses missing, proximal 2/3 shaft. Approximately adult size, gracile build.
FF04	Upper buried soil horizon VII	749	Frontal plate broken to left of sagittal plane and endofrontal midline including right supraorbital ridge, central and right segment of coronal suture	N/A	Adult	?Male	None	Good. All edges well rounded including those adjoining other fragments. Crack radiating from juncture with SF264 to midline of frontal.	SF271. Articulates with SF230, SF264, SF275. Non-metric trait: Open supraorbital notch.
FF04	Upper buried soil horizon VII	749	Parietal and frontal plate fragment including left segment of coronal suture.	Left	Adult	Unknown	Large button osteoma on sagittal plate 14x9mm.	Good. All edges well rounded including those adjoining other fragments.	SF264? (Hard to read). Articulates with SF275, SF230, SF271.
FF04	Upper buried soil horizon VII	749	Supraorbital ridge and partial frontal orbit.	Left	Unknown	?Male	None	Good. All edges well rounded including those adjoining other fragments.	SF283. Articulates with SF271. Non-metric trait: supra-orbital notch.
FF04	Upper buried soil horizon VII	749	Sagittal plates including most frontal section of sagittal suture.	Left and Right	Adult	Unknown	None	Good. All edges well rounded including those adjoining other fragments.	SF275. Articulates with SF230, Sf264 and SF271.
FF04	Upper buried soil horizon VII	749	Frontal plate fragment including small segment of coronal suture	Left	Adult	Unknown	None	Good. All edges well rounded including those adjoining other fragments.	SF230. Articulates with SF264, SF271, SF275.
FF04	Upper buried soil horizon VII	749	Long bone shaft fragment	Unknown	Unknown	Unknown	None	Cortex only. No trabecular bone in section indicates long bone. All edges well rounded.	SF281

Figure 8.11. Human bone catalogue

can develop within any osseous structure, yet are most frequently located on the external fronto-parietal region of the cranium, and usually occur singularly, as is found in this individual. These small, smooth, rounded, dense, bony outgrowths, which rarely exceed 10mm in diameter, are generally distinguished from other such hyperostotic conditions by the presence of a slight undercut edge around the base of the outgrowth, at the boundary with the unaffected surface (Ortner and Putschar 1985). The undercut is noticeably absent in this specimen; however, it could have been abraded by the aquatic taphonomic processes it was exposed to (see discussion below).

Conclusions

Although five fragments originate from the same individual and were found in close proximity to one another, no two pieces articulated *in situ*. Additionally, the fragmented nature of this small assemblage and lack of direct association with any feature precludes discussion of a burial ground, and conversely indicates surface dispersal of human bone that became incorporated into the depositional matrix as the water level fell. Surface markings are consistent with burial in a fluvial environment, suggesting taphonomic change in water prior to becoming interred in the peat or gravel contexts.

Owing to the small and disarticulated nature of this assemblage no further comment can be made on human health, as we cannot be certain that the fragments originated from individuals from the same population.

Bone and antler objects

By Marcus Brittain

An assemblage of four antler and bone tools, comprising a bone needle, an antler pick, and antler cheekpiece and a toggle, all found during excavations along the Northey landfall in 2003 and 2004, are described here. Another toggle found in dyke upcast during the early 1990s is also described. A broad Late Bronze Age to Early Iron Age date may tentatively be assigned to each item.

Two artefacts found during topsoil removal of the 2003 trenches included a small polished bone needle (length 85mm, thickness 4mm), broken at the eye (Fig. 8.12). As Jill Hooper mentions in Chapter 6, the removal of a linear V-shaped area of bone from a horse distal metatarsal on the Northey landfall may have been for the manufacture of a bone needle and may suggest that such items were being manufactured on location. An eroded red deer antler pick or hook (length 300mm, diameter 35–55mm) was also found in unstratified levels. A similar object was found among the posts in the Preservation Hall excavations, Area 8 (Pryor 2001, 90–1). Antler picks make little sense in a wetland environment unless they are by-products from the manufacture of other antler items; although heavily eroded, this object shows no signs of this process. However, the suggestion that they may have been used as hooks to raise fish traps was made by Louwe-Kooijmans (1974, Fig. 106), who found several closely associated with fishing in Beaker contexts in the Netherlands. An alternative suggestion, still within the theme of fishing, is that the pick was used as a 'priest' or baton to stun or kill a catch.

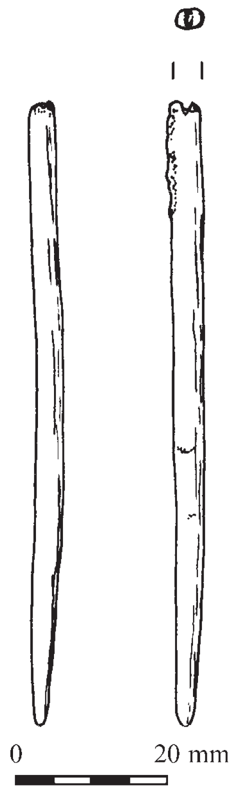


Figure 8.12. Polished bone needle

An antler cheekpiece and an item sometimes termed a toggle were found in trench 2003/1 (Fig. 8.13). Another item of toggle form was found on the surface, in dyke upcast close to Area 6, during the early 1990s. The rarity of cheekpieces in Britain has attracted attention (Britnell 1976), whereas toggles lack comparative discussion or synthesis. Although toggles may represent a different category to the cheekpieces, they are often found within the same context, yet their function remains elusive. It has been mentioned elsewhere that their usage may have varied; in some cases they may have belonged to the assemblage of bone and antler harness equipment (Bulleid and Gray 1917, 440), as strap unions or cheekpieces. Likewise, similarities in the use-wear signatures and manufacturing processes between what are typologically identified as toggles and cheekpieces at Flag Fen necessitate their comparative analysis, and the three items that have been found to date are discussed together here and placed in the broader context of cheekpieces in Britain and beyond.

They may be summarised thus:

1. Lower (thicker) end of cheekpiece (max. dia. 21.6mm), broken in antiquity. Red deer antler with rectangular slot on one side (7×25mm); long axial perforation (dia.

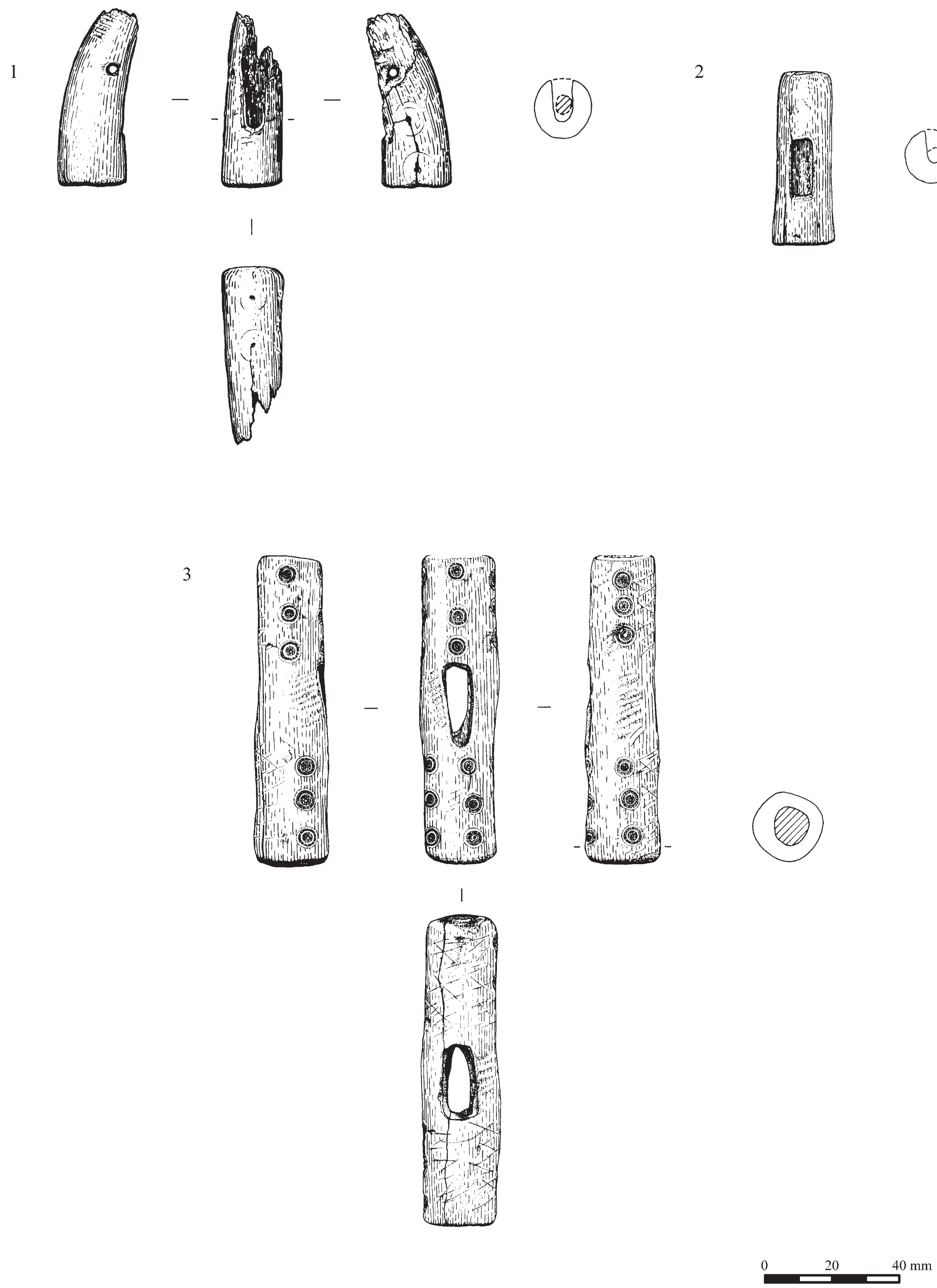


Figure 8.13. Antler cheekpiece (1) and toggles (2 and 3)

7.4mm); transverse cylindrical perforation, diameter 4mm; surviving length 52.5mm. Polished surface with decoration: two sets of three dot-and-circle designs (one with an inner and outer circle) aligned along the shaft of the outer face; six horizontally aligned parallel linear belts incised around the face at the damaged end. Probably manufactured from a brow or bez tine. Context 54, Horizon VII (buried soil).

2. Complete toggle or strap-union (dia. 19.5–15.2mm). Red deer antler with single slot off-centre on one side to interior hollow (17.8×6.7mm); long axial perforation (dia. 5.2mm); length 52.3mm. Polished surface with no decoration. Signs of wear perpendicular to slot on inner and outer lip. Probably manufactured from a brow or bez tine. Finds number 86, context 673, probably Horizon V (buried soil).

3. Complete toggle or strap union (dia. 18.5–23mm). Red deer antler with single slot (24.1×10.1mm) through entire thickness of short axis; long axial perforation (dia. 11.2mm); length 92.4mm. Polished surface with decoration: six sets of three dot-and-double-circle motifs oriented along the convex surface of the shaft, with three sets located between each end and the central slot covering three-quarters of these surface areas; multiple cross-hatching striations aligned parallel with dot-and-circle motifs between each end and the central slot covering remaining one-quarter of these surface areas. It is unclear whether these striations are intentional decorative motifs or post-depositional scratches. Of the straight type, rather than the curved form represented by the cheekpiece and toggle from trench 2003/1. Possibly manufactured from a trez tine. Surface find in dyke upcast close to Area 6.

Since cheekpiece (1) was damaged in antiquity, it may best be classed by placing it within the twofold identification devised by Longley (1980, 29–30). In the first class, which is predominantly of a southern British distribution, multiple drilled perforations or 'peg holes' are found as transverse attachments to the cheek strap slot, and the tip of the antler tine has not undergone removal. Cheekpieces of the second class display more variation, but may include a single drilled perforation, the use of deliberately hollowed ends, the perforation of the entire thickness of the cheekpiece by a slot, or a combination of the three features. With the tip of cheekpiece (1) missing because of the break, and a single perforation transverse with the cheek slot, it clearly falls into Longley's Class II. As such, it has a number of affinities with other cheekpieces from the Late Bronze Age in Britain. Typologically the closest parallels are found at Shinewater Park (J. Seaman pers. comm.), Bedlow (Head 1938), Washingborough Fen (Coles *et al.* 1979) and Runnymede Bridge (Needham 1992, 64, plate 3). The nearest find spot of a cheekpiece to the Northey landfall is at Eyebury Quarry, 3km north-east of the Flag Fen basin, from a secure Late Bronze Age context (Riddler 2008). However, with multiple drilled perforations this example falls into Longley's Class I and is very different in character from that found at Northey. Regarding decorative style, there are few indigenous comparative examples. Striations of horizontal zoning are rare, with only the Washingborough Fen cheekpiece displaying four bands of quadruple horizontal striations along the entire length of the shaft (Coles *et al.* 1979). Concentric circles or cup-and-ring motifs are equally rare, and are more often displayed on antler or bone combs or handles, as found at Potterne (Seager Smith 2000, 231). The combination of the two designs on the cheekpiece from Northey is unique in Britain; broadly contemporary examples of this combination are found, although not in abundance, across the continent, such as from the hillfort at Pákozdvár, Hungary (Choyke 1979, 16).

Toggles about the size of (2) are not uncommon; the larger dimensions of (3), in contrast, are unusual; similarly, a longitudinal hollow in toggles is not commonplace, as examples at Heathery Burn and Potterne illustrate (Seager Smith 2000, 228–30; Greenwell 1894, 109–10). However, examples of forms approximating to the shape and size of (3) with longitudinal hollows are found in later contexts and sometimes regarded as cheekpieces; examples include those from the Roman garrison town at Corbridge, Northumberland (author's notes: from visit to Corbridge Museum, 2008). A date similar to these is technically possible for (3), with the Roman Fen Causeway passing near to the find spot, but in spite of the unstratified nature of its discovery a Late Bronze Age date is more likely owing to the quantity of finds from this period in Area 6. Furthermore, a toggle comparable to (3) has been found in recent excavations of the Late Bronze Age site at Washingborough Fen, although again as a residual find in a modern context (Allen 2009, fig. 4.13). As with cheekpiece (1), the dot-and-(in this case double-)-circle decoration is rare; if the cross-hatching is part of a deliberate decorative motif then this too would be unique to Britain, although continental examples do exist (*e.g.*, Roes 1963, plate 58). The recent excavations at Washingborough Fen have also uncovered a toggle comparable to (2) from a Late Bronze Age context (C. Allen pers. com.) which presents an interesting correlation with Flag Fen since both sites currently have three antler items that are similar in form and are potentially all cheekpieces or strap unions.

The nature and context of deposition of the Flag Fen antler and bone assemblage, and of the cheekpiece and toggles in particular, has parallels with other wetland sites, especially Shinewater Park in Sussex, where a cheekpiece was found alongside a Late Bronze Age timber causeway with substantial assemblages of metalwork and animal bone (Woodcock 1998; Greatorix 1995). It is possible that a similar structure may have been positioned at Washingborough Fen, or that the assemblage of pottery, antler and bone had been washed from a waterfront site further upstream (Coles *et al.* 1979). This may also be the case for a cheekpiece dredged from the Thames at Sion Reach (Lawrence 1929), although formal deposition in this instance is likely. The waterfront location of the Northey finds may be further compared to Runnymede Bridge, which was also associated with substantial assemblages of metalwork (Longley 1980; Needham 1991, 154; Needham and Spence 1996, 187–93). Alternatively, the presence of toggles and cheekpieces at Northey within a midden-like deposit may find comparison with the context of similar finds at Potterne (Lawson 2000; 1994), at least in practice if not in scale.

Metalwork from Flag Fen (1999–2005)

By Dot Boughton

Introduction

The following report will consider a small assemblage of metalwork recovered during excavations on the Northey landfall (NTY99, FF03 and FF04) and on the north-west stretch of the post alignment within the Flag Fen basin

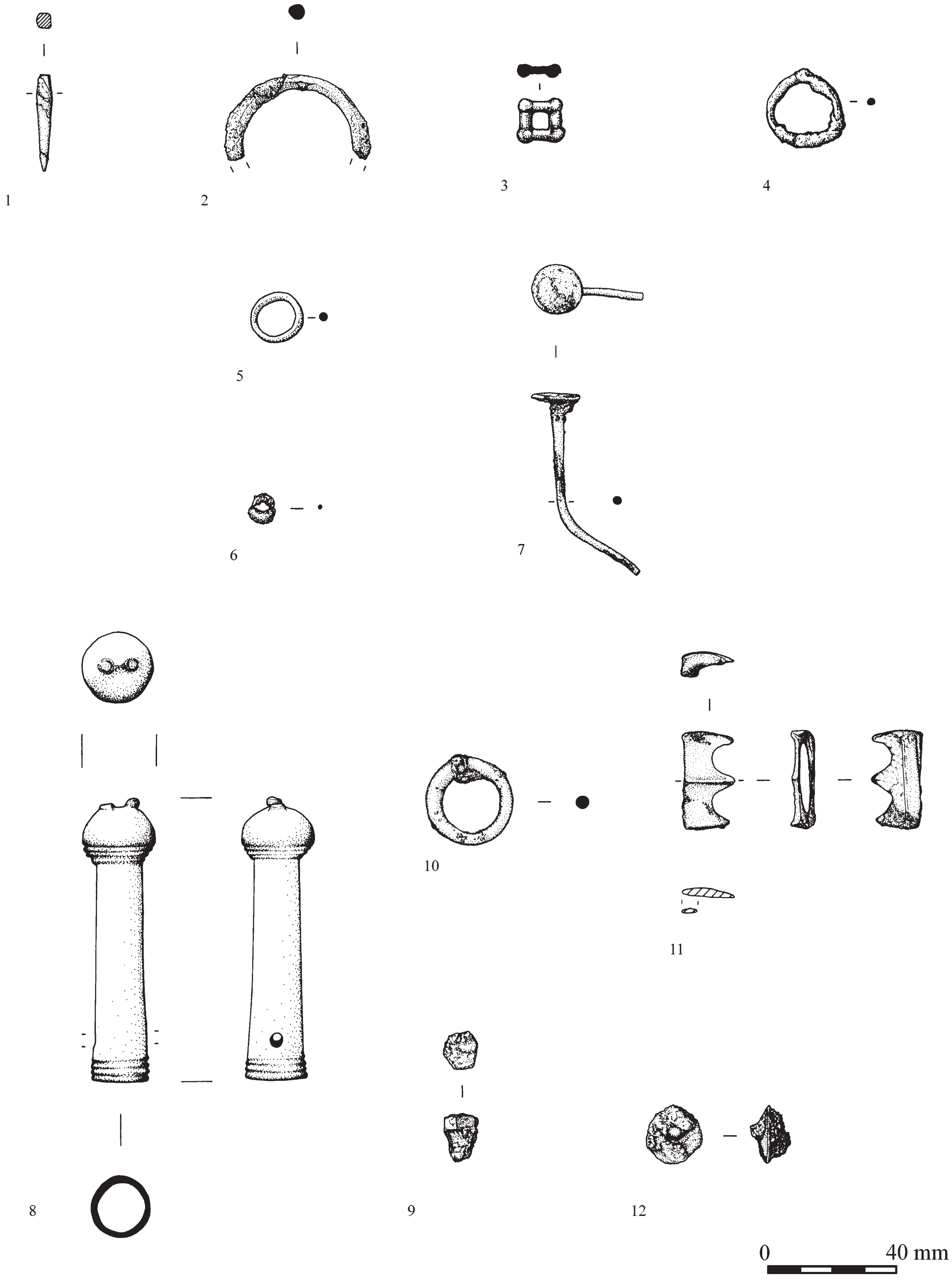


Figure 8.14. Metalwork from Flag Fen (1999–2005)

(FF05). The twelve objects have been given consecutive catalogue numbers which will be referred to in the discussion (see below): FF03=Nos 1–7; FF04=Nos 8–11; FF05=No. 12.

No metal analysis was carried out, and any observation of the objects' metallurgy must therefore be tentative. Object nos 1–6 and 8–12 are non-ferrous and made from cast copper alloy, while object no. 9 is probably made from cast iron and is possibly post-medieval or modern in date (Fig. 8.14).

While the latest find, a broken disc-headed pin (no. 12), came from the top of the post alignment and was found in

association with slag and burned stone (probably dating from the Iron Age), most of the other objects came from drier levels to the south-east on the landfall of Northey 'Island', where they were found within layers of compacted redeposited gravel (Chapter 3, this volume).

Catalogue

Abbreviations

Dia:	diameter
Ht:	height
L:	length
Th:	thickness
W:	width
Wt:	weight

Green Wheel project (NTY99)

1. Fractured copper-alloy awl (context 270, D1), SF2.
   Almost complete small, tanged cast copper-alloy awl. The object's cross section is circular towards the point and square at the tang. The upper part of the tang is missing, but otherwise the item is complete.
   L 31.14mm; W (top) 3.69mm; W (widest) 5.08mm; Wt 3.01g.
2. Broken copper-alloy ring (context 009, Horizon II), Test Pit 10, SF1.
   One half of a cast copper-alloy ring with circular cross section and uneven thickness.
   Dia (internal) 34.82mm; Dia (external) 45.15mm; Dia (ring) ranges from 4.51mm to 5.03mm; Wt 9.32g.

Flag Fen FF03

3. Copper-alloy (?) square object (SF71); upper buried soil horizon VII, 2003/1.
   Small square fitting with bulbous corners, probably made from cast copper alloy. The *c.*5mm-long side bars are decorated with up to three(?) ribs/grooves. Casting flashes only partly removed. Brown/blackish patina with white flecks and rough patina. Complete.
   The fitting was cast in a two-piece mould whose two halves were misaligned during the casting process, which resulted in it being slightly misshapen. The colour suggests that it was cast from high-tin copper alloy, but this will have to be confirmed by metallurgical analysis.
   L (outside) 13.79mm; L (inside) 5.72mm; W (corner) 4.51mm; W (bar) 2.82mm; Wt 2.68g.
4. Copper-alloy ring (SF72); upper buried soil horizon VII, 2003/1.
   Bent copper-alloy ring, circular cross section. Various shades of green patina and rough surface. Complete.
   Dia (external) 23.49×24.87mm; Dia (internal) 15.93×18.90mm; Th *c.*1.97mm; Wt 2.2g.
5. Copper-alloy ring (context 066): upper buried soil horizon VII, 2003/1.
   Somewhat bent copper-alloy ring, circular cross section. Various shades of green patina and fairly smooth surface. Complete.
   Dia (external) 15.58×16.68mm; Dia (internal) 10.79 × 12.41mm; Th 2.27mm; Wt 1.17g.
6. Copper-alloy ring (SF40): redeposited gravel horizon VIII, 2003/1.
   Very small bent copper-alloy ring. Various shades of green patina and rough surface. Thick layer of corrosion residue on inside of fragment. Broken in half.
   Dia (external) *c.*8.28mm; Dia (internal) *c.*5.32mm; Th *c.*1.39mm; Wt 0.35g.
7. Copper-alloy pin (SF84); buried soil horizon V, 2003/1.
   Copper-alloy disc-headed pin, shank bent, tip missing, but otherwise intact. Dark green patina and smooth surface. Shank as well as upper and lower face of disc plain.
   L 56.87mm (unbent 70.42mm); Dia (shank) 3.27mm; Dia (disc) 15.96mm, Ht (disc) 2.35mm, Wt 7.8g.
8. Copper-alloy flesh-hook terminal (SF33); buried soil horizon V, 2003/1.
   Copper-alloy flesh-hook terminal with silvery-green patina and smooth surface. Long tubular socket, slightly tapering towards the bulbous globular terminal. The area between the globular terminal and socket as well as the opening of the socket are decorated with three ornamental grooves each. There are two rivet holes, set exactly opposite each other just below the ornamental grooves around the socket opening. Two stubs at the very end of the globular terminal suggest either a miscast or broken-off suspension loop. The two stubs appear much worn, one of them being much flatter than the other, as well as less-defined. This suggests an initial casting flaw rather than damage or breakage.
   L 86.66mm; Dia (top, outside) 19.32mm; Dia (top, inside) 14.89mm; Dia (globular terminal) 22.73mm; Dia (rivet hole) 3.91mm; Wt 61.36
9. Iron nail/screw(?) head (Context 089); buried soil horizon V, 2003/
   Heavily corroded head of iron nail or screw(?). The head appears to be hexagonal, the shank is either very short or broken. Very corroded. Possibly post-medieval/modern
   Dia (head) 11.54mm; Dia (shank) 6.94mm, L 13.29mm; Wt 4.48

Flag Fen FF04

10. Cast copper-alloy ring, complete (SF109); upper buried soil horizon VII, 2004/3.
    Complete cast copper-alloy ring with circular cross section and uneven thickness.
    Dia (external) 27.61mm; Dia (internal) 18.08mm; Dia (ring) ranges from 3.64mm to 5.44mm, Wt 8.62g.
11. Cast copper-alloy strap or belt slide (SF136); redeposited gravel horizon III, 2004/3

Complete cast copper-alloy strap slide with three spurs, undamaged. While the obverse surface is very smooth, the reverse appears rough and untreated. On the obverse, the spurs were enhanced by low ridges that connect the tips of the spurs with the base of the slide at a right angle. On the reverse, a thinner cast-metal strip rises from the lower part to allow for a strap to be pulled through.
L 30.39mm; Ht (spike) 16.01mm; Ht (between spikes) 8.39mm; Wt 6.87g.

Flag Fen FF05

12. Cast copper-alloy disc-headed pin, broken (SF45), peat (405), 2005/4.
Upper half of cast copper-alloy disc-headed pin, broken probably by mechanical digger scraper. Lower half missing, probably broken in antiquity.
L (both fragments) approx. 45.51mm; Dia (disc head) 17.18mm; Ht (disc head) 1.59mm; Wt (both fragments) 5.04g.

Discussion

With the exception of no. 9, which appears to be an iron nail or screw of possibly post-medieval or modern date, and the possible exception of object no. 3 (unidentified), all objects were made from cast copper alloy and date to the Late Bronze Age. Moreover, with the possible exception of the unidentified object no. 3, all belong to the metalwork assemblages of Late Bronze Age II and III (Wilburton and Ewart Park/Carp's Tongue). Following Coombs' division of metalwork from Flag Fen (2001, 282ff), these new finds can be added to three of his groups: Tools; Dress and Display; and Miscellaneous (Fig. 8.15).

The copper-alloy awl (no. 1), which was discovered during the Green Wheel project, belongs to a group of at least sixteen very similar awls found at Flag Fen and the Power Station that were discussed in detail by Coombs (2001, 287–8). Although awls are known from Middle Bronze Age contexts, it is more likely that the awls discovered at Flag Fen, the Power Station and Northey 'Island' all belong to later Bronze Age contexts. The metal analysis for the awls published in the Flag Fen report of 2001 (nos 65–7; 69–73) suggested an exclusively Late Bronze Age II/III (Wilburton–Ewart Park, ca. 1140–800 BC) date for them (Coombs 2001, 265–7; Needham and Rohl 1998, 101, Fig. 21).

Class of material	*Description*
Tools	1 awl
	1 flesh-hook terminal
Dress and Display	2 disc-headed pins
	1 forked belt-slide
Miscellaneous	5 rings of various sizes
	1 unidentified square fitting

Figure 8.15. Categories of metalwork, Following Coombs' division of metalwork from Flag Fen (2001, 282ff).

A much more unusual find is the complete cast copper-alloy flesh-hook terminal (no. 8). This object can be compared to similar specimens from the Wilburton and Isleham hoards, which both contained flesh-hook terminals with globular terminals and bands of ribbed or grooved ornament (O'Connor 1980, 148). According to O'Connor, there are also comparable examples from French hoards such as Boutigny hoard II and Villeneuve-Saint-Georges (O'Connor 1980, 148; Fig. 49A, no. 31).

On this note it should be added that the complete flesh-hook discovered at Flag Fen and subsequently discussed by Coombs probably belongs to Late Bronze Age I (Penard Phase) (Coombs 2001, 288–9). This date was derived from the dating of its closest parallel, the flesh-hook from the Feltwell Fen hoard in Norfolk, which was found inside a Class A1 cauldron which Gerloff dates to the Penard Phase (Coombs 2001, 289; Gerloff 1986). If the flesh-hook and the flesh-hook terminal found at Flag Fen are not contemporary, but date to the Penard (Late Bronze Age I) and Wilburton (Late Bronze Age II) Phases respectively, this could possibly indicate that ritual feasting may have had a longer tradition on this site than was previously thought (Coombs 2001, 289).

Among the recent Flag Fen and Northey assemblages were two cast copper-alloy disc-headed pins (nos. 7 and 12). Most of the disc head of no. 12 is corroded and encrusted with metallic/lithic residue, which makes it impossible to make out any kind of surface decoration at this stage in the investigation. Coombs suggested that the settlement site at Flag Fen and the Power Station produced an unusually large number of Bronze Age pins of varying types, but none of the ones published in 2001 closely resemble the specimens being discussed here (Coombs 2001, 289). While some previously published examples may be similar (nos. 175, 180, 183 and 185), none of them have such a pronounced flat disc head, and some of the earlier finds also have a small central knob, which the two latest finds lack.

O'Connor (1980, 203–4) argued that the dating of disc-headed pins found in Britain is particularly difficult because they are part of a fairly heterogeneous group that was spread over large parts of Western and Central Europe, and, furthermore, suggested that genuine disc-headed pins are rare in England outside Early Bronze Age contexts and that they are generally more common in Ireland, although the Irish pins are usually decorated. The metal analysis which was previously carried out for pin nos. 174, 179 and 180 suggested that they were of Late Bronze Age II (Wilburton) date (Coombs 2001, 274–5) but, since the latest finds of disc-headed pins cannot be closely matched to the known pins from Flag Fen and a date on stylistic grounds is difficult to suggest, only a general Late Bronze Age II/III date for the two disc-headed pins is suggested here.

The third item classed as 'decorative fitting' or 'display

item' is the forked belt slide or 'slide with three spurs/peaks' (no. 11). This item is virtually identical to belt slides of various sizes discovered as part of the Welsh Late Bronze Age hoard from Parc-y-Meirch, Abergele, Denbighshire (Sheppard 1941). This hoard contained over ninety objects, most of them in pairs, fours or eights, which were seemingly part of harness equipment for at least two horses (rings, jangles, slides and so on). It appears that, initially, there were at least forty-two specimens of these 'slides with three spurs' from the Parc-y-Meirch hoard, which could be further divided into three smaller groups according to size (Sheppard 1941, Plate IV, nos. 42–57; Plate VIa, nos. 32–41 and Plate Va, no. 71). While the slide from Northey does not fit exactly into any one of these three groups based purely on size, it seems fair to suggest that it is most similar to the second group of toothed strap slides. This is based on the observation that the strip on the reverse was not welded on and the object does not appear to be a 'miniature version' (Sheppard 1941, Plate Va, no. 71).

Objects like these, although generally very rare, are also known to have been included in hoards from Dreuil-les-Amiens, Somme (slide with five peaks), and Welby, Leicestershire (Evans 1881, 403–4, Fig. 504; O'Connor 1980, 380, 388, 402–3, no. 177, Fig. 62A, 5). Furthermore, it is important to add that although the Parc-y-Meirch hoard was initially thought to be of Late Bronze Age III date (O'Connor 1980, 380), a more recent metal analysis of some of the hoard's contents suggested a Late Bronze Age II (Wilburton) date (Needham and Rohl 1998, 101).

The six objects grouped here under 'Miscellaneous' are five nondescript cast copper-alloy rings (nos. 2, 4, 5, 6, 10) and a single unidentified object (no. 3) which may well have been a square fitting or ornament. Cast copper-alloy rings of varying diameters and cross sections have been found at the sites of Flag Fen and the Power Station (at least forty specimens), but it is almost impossible to speculate on their uses, which most probably range from 'the purely ornamental to the functional (*e.g.* chain mail)' (Coombs 2001, 291). However, previous metal analysis carried out on two of the plain cast copper-alloy rings, nos. 224 and 229 (Coombs 2001, 274–5, 278–9), suggested a Late Bronze Age III (Ewart Park/Carp's Tongue) date.

The only object in this assemblage not apparently made from cast copper alloy (no. 11) appears to have been made from cast iron instead. Its shape and size suggests it is the head of a screw or nail of possibly post-medieval or modern date.

To sum up: twelve objects of ferrous and non-ferrous metalwork were discovered during excavations on the Northey landfall and on the north-west stretch of the post alignment in the wetland of the Flag Fen basin. With the certain exception of the only ferrous object (no. 9) and the possible exception of a single unidentified object (no. 3), all items clearly belong to the metalwork assemblages of Late Bronze Age II and III (Wilburton and Ewart Park/Carp's Tongue) and thus fit in well within the overall chronology of metalwork from the area.

The most interesting of the twelve items are the toothed belt slide and the flesh-hook terminal, both of which were found at the Northey landfall. These are very rare items in Britain, with comparisons found only in contemporary hoards (*i.e.*, Parc-y-Meirch, Wilburton and Isleham).

A jet bead from Flag Fen, 2004

By Alison Sheridan

The two bead fragments discussed here (SF213 (context 794) and SF240 (context 795)) came from dumped sand and gravel deposits within the upper buried soil (Horizon VII) in 2004/3 of the 2004 excavations (Chapter 3, this volume). The layers in which they were found were next to each other and were very similar; they probably represent separate basket or bucket dumps intended to consolidate soft ground at the extreme edge of the Northey landfall. The source of the gravel would have been higher up on Northey 'island'. The redeposited gravels contain broken fragments of bone, pottery, numerous flints, metalwork and the two bead fragments discussed here. The presence of these finds suggests that the gravel was dug close to a settlement.

The two fragments comprise around half of a squat biconical bead. The estimated external diameter is *c.*25mm, and the diameter of the perforation is *c.*10mm; the width of the hoop is 7.4mm and the bead's thickness 12.5mm. The exterior surfaces are straight and meet at a fairly sharp junction at the bead's mid-height; the interior is gently convex (indicating that the perforation had been hollowed from both sides); and the upper and lower edges vary from rounded to gently squared-off. The exterior had been polished to a high sheen, and the interior has a medium sheen. Faint tool marks, in the form of shallow, multi-directional striations, can be seen on parts of the interior (albeit partly obscured by lacquer); these suggest that the perforation had been made – or at least completed – by carving. On the smaller fragment (SF240), at the bead's sharp outer edge, striations around a small naturally embedded quartz grain suggest an attempt to remove it (or a neighbouring grain) by gouging.

There are many shallow ancient scratches on the exterior and interior surfaces and top and bottom edges, but whether these are the result of wear or of post-depositional damage is unclear. While there are no obvious signs of wear (*e.g.*, grooves worn by a thread), this is not surprising given the width of the perforation; but thread polish may well have contributed to the smoothness and sheen of the interior. The fracture surfaces have small flakes and chips, and in one case a hinge fracture, at their edges.

The material is black and compact, and probably Whitby jet, as indicated by several features: (1) it is slightly warm to the touch; (2) one of the flake scars is conchoidal; (3) the subsurface revealed by some of the scratches is brownish; (4) embedded quartz grains are an impurity characteristic of jet; and (5) there are a couple of small, shallow, oval-shaped surface hollows on the larger fragment (SF 213) that may indicate natural irregularities on the outer surface of the

parent pebble. Finally, the identification of the material as jet was confirmed through non-destructive compositional analysis by X-ray fluorescence (XRF) spectrometry (undertaken by Lore Troalen, National Museums Scotland (NMS)): the bead displays the characteristic high zirconium, low iron signature of jet. While Whitby (and environs) is not the only source of jet in Britain, it is the only significant source, and it is known to have been used at various periods in the past; there is no evidence that the small source of true jet at Kimmeridge (Watts *et al.* 1997) had been exploited. In any case, the bead's compositional signature is consistent with that of samples of jet from the Whitby area.

Discussion

Squat biconical beads of jet (and other materials) are known to have been manufactured during both the 2nd millennium BC (*e.g.*, at Callis Wold 114, East Riding of Yorkshire: Mortimer 1905, Fig. 426, confirmed as jet by XRF analysis at NMS) and the first half of the 1st millennium BC (as in the hoard from Llangwyllog, Anglesey, confirmed as jet by XRF analysis by Mary Davis: Sheridan and Davis 1998, Fig. 12.7). Given the nature of the pottery and metalwork found nearby at Flag Fen, and other stratigraphic and dating evidence as discussed elsewhere in this volume, it seems most likely that the Flag Fen bead is of Late Bronze Age date. The angularity of its profile echoes the shape of some Late Bronze Age bangles of jet-like material (*e.g.*, from the Heathery Burn hoard, County Durham: Britton and Longworth 1968, nos. 9–11) and is matched, as noted above, by the (rather lop-sided) bead from Llangwyllog; but other Late Bronze Age beads of jet and jet-like materials tend to have rounder sides. Many have been found as parts of necklaces, associated with beads of amber (as in the hoards from Balmashanner, Angus (Eogan 1994, plate 14) and High Throston, Cleveland (B. Vyner pers. comm.)). It is thus quite possible that the Flag Fen bead had originally formed part of a necklace.

This bead would have been a precious possession, and may well have been used as an amulet: jet, like amber, has special properties (including its electrostatic nature) and, as a stone that is warm and that can be burnt, is an anomalous material. These materials have been ascribed magical properties over the millennia and around the world (Sheridan and Davis 2002); and the fact that jet beads (or imitations in substitute materials) have been found associated with amber beads in Late Bronze Age necklaces lends support to the suggestion that they were worn not only as status symbols but also as amulets to protect their elite wearers.

9. Discussion

Francis Pryor

This volume marks the end of the first stage of research into the archaeology of the Flag Fen basin, but that does not mean that work has ceased. Indeed, far from it, because the second phase has already begun, with a series of major excavations along the southern side of the basin, roughly between Stanground and Whittlesey. These projects have been carried out by the Cambridge Archaeological Unit in close collaboration with the team at Flag Fen. During this second phase of commercially funded research, Cambridge Archaeological Unit and other units have also organised important excavations to the north of Flag Fen at Fengate and, further to the east, in the gravel quarries around Eyebury, the area where E. T. Leeds began the era of modern excavation in the decade after the Great War (Evans and Appleby 2008; Evans *et al.* 2009).

It has to be acknowledged that most of this research is of its very nature destructive, but it is carried out against a background of increasing and encroaching commercial development of the Flag Fen basin. It must also be pointed out that as conditions across the entire area are becoming progressively drier the destruction of the organic component, at the very least, is in any case inevitable. There is also much controversy over the concept of 'preservation *in situ*', which, without close monitoring, is regarded by many informed authorities as ineffective or worse, in that it allows planning authorities to believe that the problem has been satisfactorily addressed, while the archaeological remains continue to decay unseen. In such circumstances developers insist that the impact on the archaeological record has been dealt with and that, despite conditions placed on development, planning authorities give consent. It then follows that any adverse effects on the buried archaeological deposits are no longer the responsibility of the developer.

At present we believe that the artificial Mere at Flag Fen, which was constructed in the summer of 1987, was made just in time, before drying-out had progressed too far. Our belief in the Mere's effectiveness has been reinforced by observations of conditions around it, discussed here in Chapter 1; nevertheless, after the lapse of more than two decades it is time that simple faith be replaced by facts. A programme that monitors archaeological preservation in and around the Mere is now urgently needed.

A series of projects that monitored groundwater conditions along the post alignment and across the Flag Fen basin from the fen-edge at Fengate to the Northey landfall were undertaken from the later 1990s. These projects were carried out opportunistically, either when suitably qualified researchers offered their services to the Fenland Archaeological Trust or when funds for research could be found from other sources, such as English Heritage. The results from these projects have been drawn together and reassessed by Marcus Brittain in Chapter 1. Although the picture is variable and preservation is better in some areas than in others his general conclusion cannot be avoided: 'a time is fast approaching when detailed information may no longer be attained'.

While the condition of archaeological wood in the deeper and wetter parts of Flag Fen is still quite good, that around the fringes is much poorer, rating a condition score of 3 (moderate), which is defined as being on the borderline for meaningful analysis (Van de Noort *et al.* 1995, table 15.1). Scores of 1 and 2 (worse than 3) are also found in these fringe areas, which seem to extend on either side of the basin, although there are occasional pockets of better preservation in wetter hollows or in areas where the groundwater has been retained by natural clays. The main problem with this pattern of preservation is that the fringes of the wetland basin are precisely where one might expect to find ancient sites. These are the places where people chose to settle, being just beyond the seasonally flooded land yet within easy reach of the rich resources of the nearby wetlands. The fact that these fringe areas are still (albeit partially) waterlogged is what makes the area so archaeologically important. Piecemeal and small-scale preservation projects, which are often uncoordinated, do not work. Only large-scale landscape preservation schemes stand a chance (Holden *et al.* 2006; Lillie 2007; Van de Noort *et al.* 1995).

In some respects the revelation of wetland-edge sites like Fengate, Northey and now Must Farm, Bradley Fen and, indeed, elsewhere, mirrors the discovery in the late

19th and early 20th centuries of the Somerset 'lake villages' at Glastonbury and Meare (Coles and Minnitt 1995, with references). Today even those sites have substantially dried out, whereas preservation in the deeper peats is still good, even excellent. These wetter areas have, of course, revealed a superb series of prehistoric wooden trackways; but nonetheless there is still a substantial divide between the worlds of the wet and the dry which raises the questions: where were the trackways heading? Where are the Somerset equivalents of Fengate? We will probably never know for certain, simply because the crucially important link between wetland and dryland has been so severely affected by drying-out. Having said that, the recent discoveries of significant wet 'pockets' at Must Farm and elsewhere along the southern side of the Flag Fen basin do give grounds for hope that their equivalents might also survive in Somerset.

The preservation and condition of organic archaeological deposits has been much affected by relatively recent changes both in drainage conditions and in land use. Today the groundwater regime has altered radically from its previous (17th–19th century) form and its earlier, natural states. Proposed plans to build on and redevelop Peterborough's large Eastern Industrial Area are bound to make a bad situation worse. Scale is a significant problem. Most hydrological reports commissioned prior to major developments operate on a more general, perhaps less finely tuned scale than that demanded by archaeologists. They are concerned, for example, with major dewatering that might affect agriculture or with flooding events that could force the abandonment of houses. In the present author's experience it is almost impossible to persuade them that seemingly minute changes in the groundwater regime could have a rapid and devastating effect on archaeological remains below ground (French 2004; 2009; French and Taylor 1985). It could be argued that in many respects our inability to communicate the extent and scale of these problems to planners and developers constitutes a significant threat in its own right.

The general scarcity of what one might term 'off-trackway' activity or settlement within the wetter regions of the basin has been confirmed by a series of excavations within and around the Sewage Treatment Works, at the southern end of Third Drove, some 800m to the south-west of the post alignment (Chapter 2, this volume). Although the peaty alluvium in this area is not as thick as was originally expected, conditions were sufficiently wet to prevent the formation of more than a very thin immature soil in early–mid Holocene times. The only evidence for human activity was found in one of four trenches opened in 2003 by Cambridge Archaeological Unit, which revealed a series of long (1.5m) and abutting timbers at 0.83m OD – just 0.20m above the level of the Bronze Age timbers of the post alignment and platform at Flag Fen (Patten 2003; Pryor 2001, Fig. 1.7). Two of these timbers appeared to have been worked: there were possible toolmarks and a notch, possibly a lap-joint. One can only assume that this was part of a platform of some sort. Its construction recalls the 'log layer' found in Level 4 of the post alignment in Area 6B (Pryor 2001, 131).

In 2000 (HLF1–4 trenches) and again in 2005 (2005/1–4) (Fig. 2.2), four trenches were located along the western length of the post alignment between the fen margins at the Power Station site and the Old Visitor Centre car park, immediately west of the artificial Mere. They were spaced about 50m apart. With the exception of a machine-cut section through the entire deposit, the earlier excavation revealed only the uppermost parts of the posts, as it was merely intended to prove the existence of the alignment while also gaining some impression of preservation. The section showed the entire exposure to be dry, with drying cracks up to *c.*30mm in width through the desiccated peat overburden over a depth of more than 1m. Even when lightly covered and left alone for several days, no water accumulated there. As to the posts, only those of oak were preserved at the highest level; these could be seen to form four indistinct rows.

The excavations of 2005 confirmed that the deposits were continuing to dry out and that the posts were again arranged in rows. The presence of a walkway was noted between Rows 2 and 3, as was also observed in Area 6B (Pryor 2001, 101), but there was no convincing evidence for a walkway between Rows 3 and 4. However, sherds of PD-R pottery were found between Rows 3 and 4 and within and around the posts of Row 3. It is possible that these sherds, which probably came from a very small number of vessels, represent deliberate acts of breakage (see Pryor, Chapter 8), a phenomenon that was also observed with regard to the metal items from the Power Station site and from Area 6 (Coombs 2001). In broad terms these excavations confirmed that the post alignment indeed extended right across the western reaches of the embayment, that parts of it were used for a walkway, or walkways, and that rituals probably also took place there.

Plans published in the Flag Fen Basin monograph show the post alignment as running straight across the wetland between Fengate and Northey (*e.g.*, Pryor 2001, Fig. 1.4). Even while the report was in press, however, it had become quite apparent that the alignment kinked slightly northwards some 60m east of the platform. This was not a curve so much as an abrupt alteration of course. Marcus Brittain (Chapter 2, this volume) has noted that the 'kink' appears to coincide with a raised bank of natural gravel seen in trench 2005/1 at the most westerly point of the study (*i.e.*, that nearest the platform). It seems probable that the raised bank is a continuation of a low-lying, and now buried, natural gravel 'promontory'. While this practical explanation seems entirely plausible very similar kinks are commonly observed in cursuses and bank barrows, where they are attributed to more general phenomena in the landscape (Tilley 1994). Sadly the Fens have changed more than any other landscape in Britain, so one cannot stroll across them observing cairns on the skyline, as can still be done on the moors of the south-west; nonetheless, it is not impossible that the Flag Fen posts might originally have been aligned

on a barrow, say, on the Northey fen-edge; that alignment would then have been abandoned when the natural gravel ridge was encountered.

The excavations of 2005 provided some indirect evidence for Iron Age use of the post alignment when scatters of white pebbles were found in thin spreads of gravel in the peaty alluvium well above the Bronze Age walkway surface in the highest layer of trenches 2005/1 and 4. Very similar pale stones were found associated with an 'occupation spread' which was revealed with a post-built structure on the extreme fen-edge at the Fengate Depot Site, just off the alignment (Evans and Pryor 2001, 24). It has been suggested that the pale stones might have been deliberately selected (possibly for ritual reasons) to contrast with the dark peaty waters that concealed the rotted stumps of the Bronze Age posts.

In the mid-1990s the practice of field archaeology was revolutionised by new digital and satellite-based techniques of survey and by the widespread adoption of computer-rectified plots of oblique aerial photographs. The former made it possible to detect the kink in the post alignment just west of the platform and have enabled the Cambridge Archaeological Unit to draw up a new and very accurate baseline reference map of the Fengate archaeological landscape, including the precise position of all known trenches. With their kind permission this has been reproduced here (Fig. 9.1).

The principal British pioneer of computer-rectified aerial photography is Rog Palmer, who was commissioned by Soke Archaeological Services, then the commercial arm of the Fenland Archaeological Trust, to undertake a resurvey of all the available air photos. These were then rectified and the results plotted onto Ordnance Survey maps. David Britchfield has discussed the aerial photographic survey

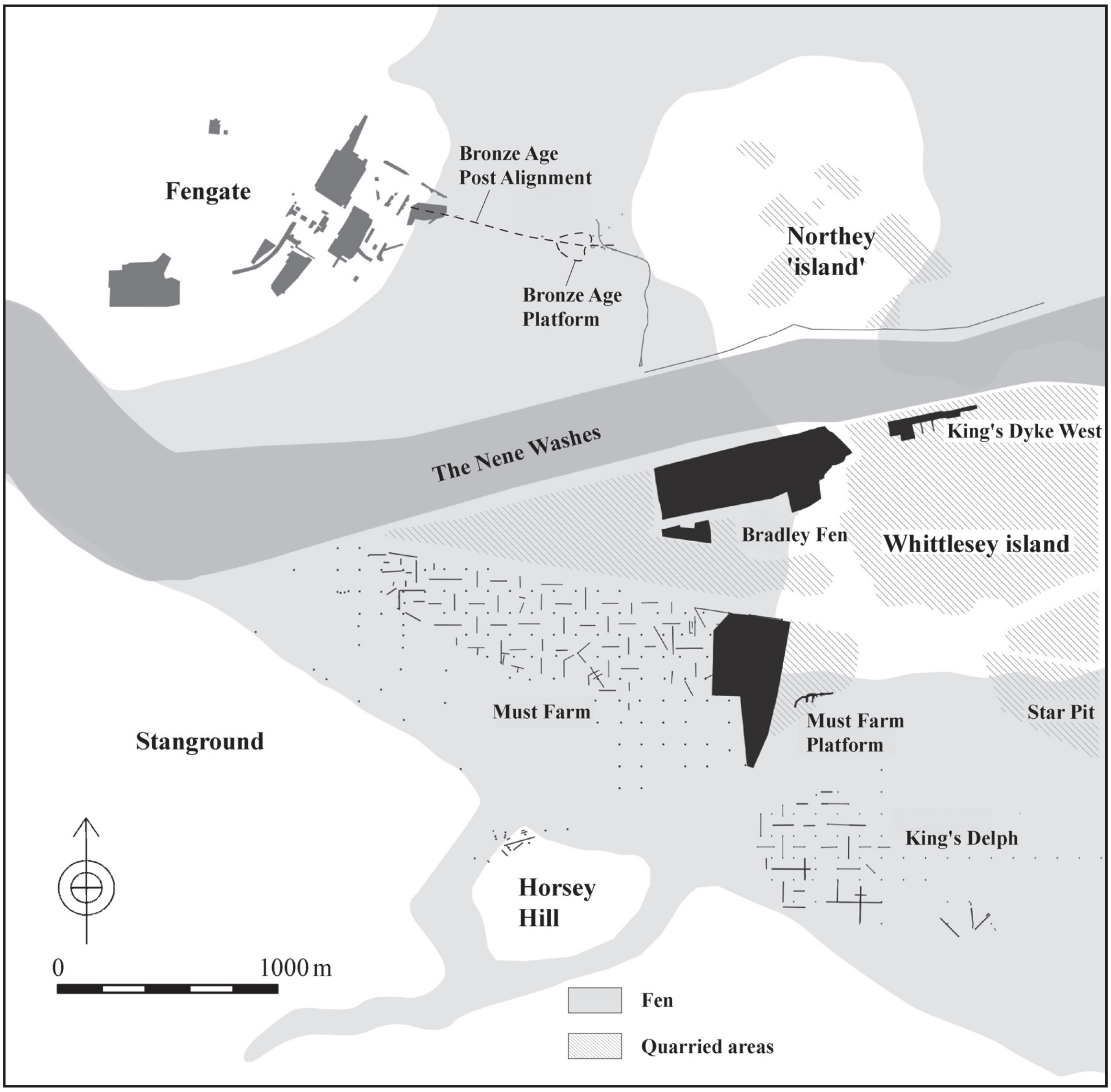


Figure 9.1. Recent investigations within the Flag Fen basin. Reproduced with kind permission of Cambridge Archaeological Unit.

and its implications in the first part of Chapter 3 here. The new maps (Fig. 3.1 and 3.2) made it clear that the Bronze Age field system along the Fengate fen-edge was about a kilometre wide and that there was open country to the west, on the cornbrash limestone (Palmer 1999). The fields along this western edge had double-ditched droveways which opened onto the unenclosed landscape, just like those to the east abutting the wetland of Flag Fen. The hypothesis first suggested in the 1970s – that the fields were essentially used seasonally, during the leaner, wetter months of winter – still seems to hold, but now we realise that the flocks and herds would also have had recourse to (much needed) open grazing to the west. This additional resource would surely have been necessary if the population of over-wintering livestock was as substantial as has been suggested (*e.g.*, Pryor 1996).

The other revelation of the new maps concerns the general layout of the Fengate field system, which now seems far less coherent than was once believed. For example, the smaller fields around the Storey's Bar Road sub-site seem almost self-contained. This might explain why they have been convincingly demonstrated to be later than those around Newark Road, a short distance to the north-east (Evans and Pryor 2001). Similarly, the droveways and rectangular fields immediately north are separated from the Newark Road sub-site by an area of unenclosed land, while the ditches of the next system, some 300m further to the north, seem to be on yet another alignment. The impression given by this layout is one of episodic development, possibly from an origin somewhere near the Fengate landfall of the much later post alignment. Each episode of enlargement was probably not a piecemeal development by, say, an individual farmer or family, but a larger-scale, perhaps communally organised enterprise in which the new system was integrated into earlier landscapes. As has been suggested for the Dartmoor Reaves, this surely indicates the presence of a controlling political authority of some sort (Fleming 2008, 187–204).

It was known during the original Fengate project of the 1970s that there were Bronze Age fields on the gentle eastern slopes of Northey 'island' and that, as at Fengate, some were also associated with the early manufacture of salt (Gurney 1980). Nonetheless their actual extent came as a surprise. Droveways were somewhat less apparent, but at least one boundary was clearly aligned on a fen-edge barrow, as of course was the case at Fengate. We had expected to recover evidence for an earlier ditched droveway at the Northey landfall of the post alignment, but this was not found despite excavation, careful re-examination of aerial photographs and a thorough geophysical survey on both sides of the Green Wheel cycleway during the *Time Team* project in 1999. Unless modern plough-damage has been exceptionally severe (and we must bear in mind here that a post-War farmer actually bulldozed the *agger* of the Fen Causeway flat, just a few metres away) we must conclude that the posts ended in an open part of the landscape.

The aerial survey showed that some archaeological features still survived above the ground, despite modern agriculture. As one might expect, survival was best on Northey, where known Roman and later features still remained as banks. The course of the Fen Causeway showed up particularly well, but it was also interesting to observe ridge and furrow at the extreme (western) edge of the fen, parallel to and immediately north of Third Drove. Not only does this confirm a medieval or earlier origin for this and perhaps the other droves of Fengate, but it also demonstrates that the Cat's Water drain, whose still prominent banks appear to have been used as a headland, marked the formal edge of the fen.

While excavations in the west were mainly confined to the post alignment, the situation to the east, at the Northey landfall, was more complex, as David Britchfield has made clear in the second part of Chapter 3. By the later 1980s the Fenland Archaeological Trust had decided in principle that its access, which was then from the east via Fourth Drove, would have to change as it was through a heavily built-up industrial area and gave the approaching visitor no clear view of the landscape. In the mid-1990s the Trust acquired the land where the post alignment reached firm ground in Northey, and it was decided to build a New Visitor Centre there which would be accessed via a short drive off Northey Road, the main route between Peterborough and Whittlesey. This project was being discussed when in 1995 Peterborough Environment City Trust announced its intention to build a cycle ring-road around the entire city as part of the impending millennium celebrations. This new cycleway was to be known as the Green Wheel and Flag Fen was to be a significant stopping place along it.

The Green Wheel project was part-funded by the Millennium Commission, whose stated intention was to open the New Visitor Centre, car park and access drive as early in the new century as possible. The archaeological work required by the new development took place in three separate campaigns, all organised by the Trust's then commercial business, Soke Archaeological Services Ltd., under the direction of David Britchfield. Early in 1999 excavation and survey took place along the line of and approaches to the Green Wheel; later that summer a three-day assessment of the post alignment landfall and a plough-damaged barrow on Northey was undertaken by Channel 4's archaeological series *Time Team*. Finally, in the following year excavations took place to investigate the precise footprint of the New Visitor Centre.

In addition to the Green Wheel, *Time Team* and Visitor Centre projects, small training excavations also took place along the edge of Northey Fen on land owned or leased by the Trust in the immediate vicinity of the Mustdyke, where the earlier Dyke Survey had revealed extensive prehistoric settlement and where a succession of dry summers had made drying-out a problem that could not be ignored. These excavations took place in 2003 and 2004 (FF03 and FF04).

Three trenches were excavated along the projected path of the Green Wheel cycleway (Fig. 3.6, trenches NT1–3). We should also note here that, where trench NT2

encountered the post alignment (at its north-western end), it was extended to the south-west to expose a larger area of posts and post-holes. In 2003 this enlargement was further extended on either side, north and south, to check for subsidiary features such as banks (Fig. 3.31: 2003/2). When the original three trenches had been completed, a further long trench (Fig. 3.21: trench NT4) was excavated along the line of the proposed access drive to the New Visitor Centre.

The results of the Green Wheel project have been written up in a full clients' report, and a reconsidered summary by David Britchfield, which also takes account of more recent developments, appears here as Chapter 3. We have mentioned that the Dyke Survey of 1982–86, which discovered Flag Fen, had also revealed evidence for Beaker settlement on the corner of the Mustdyke (Dyke 10 in the survey), at the point where it turned west into the wetter ground of Flag Fen proper. At this point the Pleistocene gravel subsoil was about a metre below the surface and prehistoric features could clearly be seen within and below the buried prehistoric soil (French and Pryor 1993, 91–100). Trenches NT1 and NT2 revealed extensive evidence for a distinct settlement of this period which included decorated Beaker pottery and a substantial assemblage of flintwork (see Pryor, Chapter 8, this volume). Features which contained Beaker pottery included smaller pits, a large hearth and post-holes; there was also clear evidence for at least three post- and stake-built fences. The fence lines apart, it was still difficult to interpret the many pits and post-holes which would suggest that this well-drained, if low-lying gravel headland had been occupied for an extended period in the centuries around 2000 BC. The apparent absence of large buildings might indicate that occupation was episodic or possibly even seasonal (presumably during the drier months of the year). The Beaker settlement covered most of trench NT1 and the southern few metres of trench NT2 and there was a gap of some 40m before the first posts of the alignment were encountered.

The stakes and posts of the post alignment were encountered in the north part of trench NT2. At this point drying-out had reduced some posts to mere vertical voids, sometimes with fragments of wood lower down. Running through the posts and oriented east–west was a substantial ditch (D1), which terminated about 2m from the eastern edge of the trench. Trial trenches and geophysical survey confirmed that this was indeed a butt-end, and not an interruption or gateway.

The upper filling of D1 had been pierced by at least a dozen posts of the alignment, thereby providing a secure *terminus ante quem* of *c.*1300 BC. The same phenomenon was observed at the Power Station site, where the posts cut into the droveway ditches 8 and 9. The northern end of trench NT2 was extended in 2003 to test whether D1 had been accompanied by another ditch, between them forming a droveway, but none was encountered. The size, profile and alignment of D1 suggests that it had formed a part of the earlier Bronze Age Northey field system. Further evidence that elements of the field system extended well down to the wetland edge was provided by trench NT3, in which another prehistoric ditch was found, also running east–west, but this time accompanied by two low gravel banks, one on each side. The fact that this ditch had been furnished with two banks rules out the possibility that it could have formed an (exceptionally wide) droveway with D1.

The long trench along the new access road revealed, in addition to a number of isolated features, two ditches of a rectilinear enclosure that showed very clearly on the air photographs. Although no diagnostic finds were recovered, the ditches' filling was more peaty than was the case, for example, with D1. On the other hand no alluvium was found in the tertiary infilling, which might have suggested a Late Iron Age or Roman date; so the best guess would suggest perhaps a date in the mid-1st millennium BC: maybe Early or Middle Iron Age. Such a date might help account for the many sherds of that date that were found a few metres downslope at the extreme fen-edge during the excavations of 2003 and 2004 (which are described shortly).

The three-day format of the main series of *Time Team* films is not appropriate to the careful examination of waterlogged remains, so it was decided to confine activities to the tracing of the post alignment east of the Preservation Hall and the investigation of a possible round barrow site which air photographs had revealed immediately north of Northey Road, close to the junction with the new access road down to Flag Fen (Fig. 3.23: trench TT2). The ring-ditch proved to be circular and its gravel-rich filling suggested it contained possible slumped barrow material. There was good evidence for an internal bank, as is usual in the area, and one disturbed and almost certainly secondary un-urned cremation was found near the outside of the area enclosed by the ring-ditch. The few flints found on the surface and in the fillings of features were all of flake- and blade-based Neolithic and Early Bronze Age type. The piercers, denticulates and irregular workshop waste so characteristic of later Bronze and Iron Age industries were absent. Although about a third, by area, of the ring-ditch enclosure had been destroyed by Northey Road and its side-ditch, a north–south extension to trench TT2 revealed the curved shape of another and similar-sized ring-ditch, also accompanied by a bank. This is part of a second barrow, an arc of which was revealed by the aerial survey.

The remaining *Time Team* numbered trenches and test pits proved the existence of the post alignment, but did not penetrate below the horizontal timbers. They revealed that the timbers were drying out and that biological activity was evident. Despite test pits and an extensive geophysical search no sign of the alignment could be found in the field east of the boundary hedge along which trench NT2, excavated a few weeks earlier, had been located. We must conclude that the posts probably ended around here. The slope of the Northey fen-edge is considerably steeper than that of Fengate and this was the point where the alluvial cover began rapidly to thin out. We know for a fact that this field had been intensively farmed since the Second

World War and it seems most probable that, even if they had originally extended further east, all evidence for the posts would have been eradicated by the plough.

The final stage of the archaeological response to the reorganisation caused by the Green Wheel developments was the examination of the footprint of the New Visitor Centre, which had deliberately been located in an area where archaeological damage would be minimal. Although that generally proved to be the case, an area like Flag Fen will always produce the unexpected.

The project began with a series of test pits, none of which produced identifiable archaeological material, with the single exception of a wooden stake in Test Pit 3. On this admittedly slight evidence it was decided to excavate the complete 'footprint' of the New Visitor Centre. These excavations took place over the winter of 1999/2000 – an ideal time to work on waterlogged wood. The enlarged excavation threw no light on the isolated stake but it did reveal the partially dried-out timbers of a short pier or landing-stage measuring 5×1.5 metres (Fig. 3.26). It was composed of parallel timbers laid side by side in an informal 'corduroy' pattern, but little trouble seems to have been taken with its construction: there were no foundations, and neither were there bearers or 'rails' beneath the logs, or any pegs or stakes. This would suggest that it was indeed a small hard-standing at the very edge of the wetland, rather than, as was initially believed, a fragment of a trackway leading across to the post alignment. Although preservation was poor, Maisie Taylor (Chapter 4, this volume) was able to identify some evidence that the logs had indeed been trimmed, probably by man.

The timbers of the pier-like structure were found between 0.55 and 0.60m OD, which coincides with the level of horizontal wood along the post alignment; an approximate Bronze Age date thus seems assured. Unfortunately the interpretation of the possible pier is complicated by the fact that Flag Fen, in common with many other wet prehistoric landscapes, has also provided good evidence for the activities of beaver. Beavers are perfectly capable of building major structures, although at Flag Fen the best evidence for them generally comes from lower Bronze Age levels (0.04–0.29m OD), presumably when the area was less disturbed by humans (Taylor, Chapter 4, this volume). However, the excavations for the Visitor Centre produced a further ten pieces of beavered wood, but from slightly higher deposits (0.45–0.54m OD). These gnawed timbers formed part of a somewhat unstructured pattern, mostly of branching roundwood, which most probably once formed part of a beaver dam or lodge (Fig. 3.27). Given the proximity of this non-man-made structure, and given too the informality of the possible pier's construction, we must not rule out the possibility that it too had been made by animals, not man.

From 2003 to 2005 the Trust organised three seasons of training excavations. We have already considered the latest of these, in which four trenches were excavated along the western post alignment (Fig. 2.2: FF05/1–4). In the two earlier seasons it was decided to further investigate the very edge of the Northey wetland immediately south of the post alignment – between it and the Mustdyke. It was apparent that this area was at serious risk of drying out following a succession of dry summers. In all, three trenches were opened (Fig. 3.6: trenches 2003/1, 2003/2 and 2004/3).

One might have expected trench 2003/1, being located close by the Mustdyke and just over 40m from trench NT2 (of the Green Wheel excavations of 1999), to have revealed quantities of Beaker material, but this was not the case and we must accordingly presume that the settlement did not extend far westwards down the gravel slope towards the deeper peats. The two contiguous dykeside trenches 2003/1 and 2004/3 mostly produced pottery of Middle Iron Age type, although some PD-R sherds were also found; the flints, too, were mostly of later type. This material was found in successive layers of redeposited gravel and although we hoped to be able to date these more precisely this did not prove possible. It would appear that the gravel layer that produced most pottery (Horizon VII) had accumulated over an extended period from, say, 900–300 BC. Finally, trench 2003/2 confirmed that the five rows of the post alignment observed in the Preservation Hall excavations (Pryor 2001, 90) continued outside the building to the east, right up to the dryland edge where the Green Wheel cycleway now runs.

The study of woodworking did not stop with the completion of the main Flag Fen Basin monograph (Pryor 2001). Although it was on a much-reduced scale, work continued on wood from Area 6D until 2005. It should also be noted that the fire of January 2000 affected these studies quite seriously, with many plans, slides and drawings being destroyed (the impact of the fire is discussed by Michael Bamforth in Chapter 4, this volume). The continuing research has allowed the development of a wood database that will, it is hoped, shortly be made fully accessible on the Internet.

This is not the place to discuss details of woodworking statistics, but work at Flag Fen and at other waterlogged sites in the area and elsewhere is now providing a more rounded picture of the social role of prehistoric carpentry. As we noted with regard to animals, wood was not seen as a mere commodity. For a start, it now seems most probable that different species of tree were given their own identities, which doubtless helped to determine how they were used. Oak, for example, seems to have been 'the timber of choice' for ritual sites, being used, for example, exclusively for that purpose at Holme-next-the-Sea, Norfolk (Brennand and Taylor 2003). In Chapter 5 here Maisie Taylor discusses how large timbers and 'Big Trees' seem to have played an important role in the Neolithic and Bronze Age, whether as massive trunks or when tangentially split to form parallel-sided planks.

The question of function or functionality is an important concern that arises from this reconsideration of timber's social role. Put another way, it was tacitly assumed that the growing preponderance of oak, as revealed in the

different level plans of wood at Flag Fen (Pryor 2001, figs 6.98–6.102) reflected a simple functional choice, which may also have been influenced by the depletion through felling, of local fen species, such as willow, poplar and alder. In the light of Taylor's recent research (Chapter 5, this volume) we should perhaps pause to reconsider. Oak is not necessarily the timber most resistant to wet-rot – in fact, alder is the most resistant. Oak is indeed strong, and it splits readily, but does one need to use it for something like a day to day functional trackway? The answer, almost certainly, is not: many other woods would have sufficed, as indeed they did in the lowest levels of the post alignment. This leaves one with the thought that perhaps the profligate use of oak was not just about function. The way that it was treated at Flag Fen and elsewhere shows beyond any doubt that oak was highly prized. Bronze Age visitors – unlike people of today, most of whom cannot tell an oak from an ash tree – would immediately have appreciated its importance. Doubtless they would have been impressed when they stood on, and were surrounded by, so much fine oak timber. Oak would have helped create a special ambience, with its unique colour and odour, especially when freshly split and the tannic acids are newly exposed to the air. It is also worth noting in this context that waterlogged sites like Flag Fen and Holme-next-the-Sea are especially important because they provide clues to the often subtle symbolisms that were an integral part of ceremonial and everyday life.

The previously discovered metalwork from Flag Fen has provided abundant evidence for long-distance contacts as far away as central Europe (Coombs 2001). Other finds, such as the unused quernstones (Pryor 2001, 427–8) or the jet bead discussed by Alison Sheridan (Chapter 8, this volume), clearly demonstrate that exchange networks, as one would expect, also existed in Britain, both along the coast and perhaps westwards, too, across to Wales. Further confirmation for these links to the west are provided by the toothed belt slide which is, as Dot Boughton notes in Chapter 8 above, 'virtually identical to belt slides of various sizes discovered as part of the Welsh Late Bronze Age hoard from Parc-y-Meirch, Abergele, Denbighshire'. This is a very unusual item and its similarity to the Welsh examples strongly suggests contact with that region in the later Bronze Age. However, one might expect high-status objects such as near-perfect quernstones or metalwork to have arrived at Flag Fen during various gift exchange cycles, and it is perhaps rather more significant that livestock were being exchanged over long distances, as Elizabeth Henton discusses here in Chapter 7. Traditionally the movement of livestock has been explained in a similar way to that of metalwork: until very recently many prehistorians have seen animals as mere commodities to be consumed during ritualistic feasting at sites like Potterne or Runnymede Bridge (Lawson 2000; Needham 1991). Instead of this unsatisfactory model, Henton discusses various patterns of husbandry to explain her observations. These suggestions certainly make better sense from the perspective of animal husbandry.

The big question that remains from our discussions of 'trade' and exchange is simple: was Flag Fen an exceptional site and was the landscape surrounding it also 'special' in some way? Had I been writing this in the later 1990s I would probably have answered the question quite firmly in the affirmative. Today (2009), however, I feel far less convinced. Too many neighbouring and regional Bronze and Iron Age sites (for example, Fiskerton, Washingborough, Bradley Fen, Must Farm) have also recently produced a wealth of 'exotic' finds. Soon, too, studies using techniques such as oxygen isotope analysis will be far more common and it seems probable that these will show that livestock was routinely moved around Britain, just as in the Middle Ages and later. Indeed, a network of drovers' roads comparable with those that came later seems likely, although of course these would not have been separated or distinguished from roads used by ordinary travellers.

I would now prefer to see Flag Fen and its hinterland as a focal part of a regional socially embedded economy, centred on the river valleys of the Nene and Welland at their confluence with the Fenland basin. The inhabitants of this regional polity would have recognised their identity as being quite distinct from those of their neighbours living around the Rivers Witham and Great Ouse, to north and south. Each of these largely autonomous regional communities would have had a structure or governance based on ties of kinship along tribal or perhaps chieftainship lines, as originally advocated by Mike Rowlands and recently restated by David Yates (Rowlands 1980; Yates 2007). Given a structure of that sort, then the post alignment can be seen as the ritual and/or political focus of the Nene/Welland community in the later Bronze Age. In the Neolithic and earlier Bronze Age the equivalent centre probably lay around Etton and Maxey in the Welland valley, but we still cannot satisfactorily explain what caused that shift of location sometime around 1500 BC.

The demise of Flag Fen also poses problems. We know that offerings were made along the post alignment throughout the Iron Age and into early Roman times (Pryor 2001). What happened next is not clear. It has been well established that flooding became an increasing danger along the Fengate fen-edge from at least the 3rd century AD, by which time the regional centre of attention had moved further west, first (in the Late Iron Age) to the flood-plain meadows of the Nene at Orton Waterville (Stead 2006, catalogue nos 31, 56, 97, 113, 122, 123 and 125) and then to the very prosperous small Roman town of *Durobrivae* (Water Newton). Perhaps it is not stretching the evidence too far to suggest that the admittedly dryland, but nonetheless extraordinary, early Christian offering of silver treasure made at Water Newton, and now in the British Museum, was not a gesture of panic in the face of an un-named approaching danger, but was a final expression of ancient ideas whose origins lay a few miles to the east, at places like Flag Fen.

Appendix 1. List of Sites and Trench Numbers

Trench numbers	Project name	Carried out by	Site code	Year
Area 1	Flag Fen Trial Trench 8	Fenland Archaeological Trust		1987
Area 2	Flag Fen Trial Trench 6	Fenland Archaeological Trust		1987/1988
Area 3	Flag Fen Trial Trench 7	Fenland Archaeological Trust		1987
Area 4	Flag Fen Trial Trench 3	Fenland Archaeological Trust		1987
Area 5	Flag Fen Trial Trench 5	Fenland Archaeological Trust		1988
Area 6A	Areas 1–10	Fenland Archaeological Trust		1984–1986
Area 6B	Area 11	Fenland Archaeological Trust		1987–1992
Area 6C	Area 12	Fenland Archaeological Trust		1989–1999
Area 6D	Area 14	Fenland Archaeological Trust		1993–2001
Area 7	Area 13	Fenland Archaeological Trust		1990
Area 8	Area 15	Fenland Archaeological Trust		1993–1994
ST97/1–13	Sewage Treatment Works, test pits 1–13	Soke Archaeological Services	STW97	1997
HLF/1–4	Heritage Lottery Funded Exploratory test pits 1–4	Soke Archaeological Services	HLF00	2000
ST00/1–11	Sewage Treatment Works, soil profiles 1–11	Soke Archaeological Services	STW00	2000
PZ1–5	Piezometer locations 1–5	Wetland Archaeology and Environments Research Centre		2002
ST03/1–6	Sewage Treatment Works, test pits 1–6	Cambridge Archaeological Unit	STW03	2003
TP1–12	Northey landfall project, Green Wheel test pits 1–12	Soke Archaeological Services	NTY99	1999
NT1–4	Northey landfall project, Green Wheel trenches 1–4	Soke Archaeological Services	NTY99	1999
VC1	Northey landfall project, Green Wheel Visitors centre excavations	Soke Archaeological Services	FFVC00	2000
TT1–7	Northey landfall project, Time Team trenches 1–7	Time Team	TT99	1999
2003/1-2	Northey landfall project, research excavations	Fenland Archaeological Trust	FF03	2003
2004/3	Northey landfall project, research excavations	Fenland Archaeological Trust	FF04	2004
2005/1–4	Exploratory trenches 1–4	Fenland Archaeological Trust	FF05	2005

Appendix 2. 2005 Phosphate Analysis

Paul Middleton

Introduction

A total of eighteen samples was submitted for analysis; these were derived from sections exposed in the 2005 season of excavation on the Flag Fen post alignment.

All but one of the samples relates to Section 101, which was sampled as a column at 50mm intervals.

Method

Bulk samples were air-dried, ground and sieved to 2mm mesh and processed under laboratory conditions. The prepared and weighed samples were treated to assess total phosphate levels using a hydrochloric acid digestion method adapted from Dick and Tabatabai (1977). The phosphate content of the processed samples was established colorimetrically by the standard molybdenum blue method described by Murphy and Riley (1962) and quantified by reference to a standard curve. All phosphate levels are expressed in terms of mg phosphorus per 100g soil.

Discussion of the phosphate analyses

The phosphate level at the base of Section 101 (102) is normal for background levels in the East Midlands and provides a benchmark against which to assess other context levels. The exceptionally high levels of the topsoil clearly owe much to the slurry treatment of the area over a number of years.

While the general trend of the results suggests a leaching effect of phosphates throughout the soil profile from the land surface, it is less clear that this is the case at the base of section 101, where levels dip and then rise again in context 107 (see table of results above). A possible explanation for this might be a fluctuating raised water table, which has had the effect of leaching nutrients down the soil profile.

The normal background levels of phosphate at the base of context 108, which is consistent with the single result from the peat layer (102), suggests that the lower levels of the soil profile are unaffected by the surface treatment of the land.

The single sample from section 103 (100) is consistent with the topsoil results from section 101.

Sample/Depth in centimetres	*Total phosphate Mg.P per 100g. soil*	*Comment*
Section 101		
Context 100		Topsoil
5	340	
10	332	
15	308	
20	344	
25	312	
Context 101		Soft clayey-silt
35	112	
40	128	
45	86	
Context 107		Firm and compact silty clay
50	180	
55	192	
60	230	
65	194	
Context 108		Soft fine silty clay with inclusions of root matter and occasional small rounded stones with pockets of fine sand
70	158	
75	170	
80	78	
85	74	
Context 102		Firm desiccated peat with a silty composition and inclusions of root matter and small pockets of fine sand
90	74	
Section 103		
Context 100		
30	324	Topsoil

Appendix 3. Wood Recording Sheet

Site:
Wood Number:
Area:
Grid E:
Grid N:
Same as:
Context:
Layer:
Level:

Sampled for ID: Y/N
Species:
Growing *in-situ:*
Type of wood:
Notes on wood type:

Coppicing evidence: Y/N
Coppicing notes:

Tool-marks: Y/N
Tool-marks on ends: Y/N
Tool-marks on other faces?
Tool mark notes:

Bark alone? Y/N
Bark condition:
Damaged: Y/N
Ancient Damage? Y/N
Damage notes:

Bark / Sapwood / Heartwood?

Condition: 1 2 3 4 5

Woodworking evidence? Y/N
Type of ww evidence:

Woodworking notes:

Charred? Y/N
Charring Notes:

Wear evidence? Y/N
Wear Notes:

What function?
Function notes:

Length(mm):
Max breadth:
Min breadth:
Max thickness:
Min thickness:
Dia Distorted? Y/N
Long axis:
Short axis:
Dia (not distorted):

Original dia:
Dimension notes:

Associations:
Association notes

Photographed?: Y/N
Film nos:
To be drawn?: Y/N
To be conserved?: Y/N
Conservation notes:

Missing data notes:
Form entered by:
Data-base entered by:
NOTES:

Appendix 4. Second Mandibular Molar Samples Listed by Context

Flag Fen 03 (FF)	41	FFA
	168	FFB
	614	FFC
	676	FFD
Flag Fen 04 (FF)	839/528	FFE
	839/503	FFF
	839/506	FFG
	832/413	FFH
Fengate 04 (FNG)	F55/3	FNGA
	F55/3	FNGB
	19/1/ii	FNGD
	ii/2/1	FNGE
	P33/1	FNGF
	P56/1	FNGG
	P28/1/ii	FNGH
	P28/1/ii	FNGI
	26/1/ii	FNGJ
	55/2	FNGK
	P12/3	FNGL
	55/1	FNGM
	55/1	FNGN
	55/1	FNGP

References

Abbott, G. W. (1910) The discovery of prehistoric pits at Peterborough. *Archaeologia* 62, 332–52.
Allen. C. (2009) *Exchange and Ritual at the Riverside: Late Bronze Age life in the lower Witham Valley at Washingborough, Lincolnshire*. Pre-Construct Archaeology (Lincoln) Monograph Series No. 1.
Allen, S. J. (1994*) The illustration of wooden artefacts: an introduction and guide to the depiction of wooden objects*. Association of Archaeological Illustrators and Surveyors, Technical paper 11.
Armitage, P. (1982) A system for ageing and sexing the horn cores of cattle from British post-medieval sites. In B. Wilson, C. Grigson and S. Payne (eds), *Ageing and Sexing Animal Bones from Archaeological Sites*, 37–54. British Archaeological Reports (International Series) S109. Oxford.
Balasse, M. and Ambrose, S., Smith, A. and Price, D. (2002) The seasonal mobility model for prehistoric herders in the south-west cape of South Africa assessed by isotopic analysis of sheep tooth enamel. *Journal of Archaeological Science* 29, 917–32.
Bamford, H. M. (1982) *Beaker Domestic Sites in the Fen Edge and East Anglia*. East Anglian Archaeology 16. Dereham.
Bamforth, M. (2006) *Assessment of Waterlogged Wood from Beccles 2006, Suffolk*. Unpublished report, L – P : Archaeology LP0496L. London.
Barrett, J. C. (2001) Prehistoric pottery from the Power Station and Flag Fen. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 249–54. English Heritage Archaeological Reports. London.
Beadsmoore, E. (2005) *Edgerley Drain Road, Fengate, Peterborough: An Archaeological Excavation*. Cambridge University Archaeological Unit Report No. 686. Cambridge.
Beasley, M., Brown, W. and Legge, A. (1993) Metrical discrimination between mandibular first and second molars in domestic cattle. *International Journal of Osteoarchaeology* 3, 303–14.
Behrensmeyer, A. K. (1978) Taphonomic and ecologic information from bone weathering. *Paleobiology* 4, 150–62.
Behrensmeyer, A., Gordon, K. and Yanagi, G. (1986) Trampling as a cause of bone surface damage and pseudo-cutmarks. *Nature* 319, 768–71.
Biddick, K. (1974) Animal bone from 2nd millennium ditches. In F. M. M. Pryor *Excavation at Fengate, Peterborough, England: The First Report*, 225–32. Royal Ontario Museum Archaeological Monograph 3. Toronto.
Björdal, C. and Nilsson, T. (2002) Waterlogged archaeological wood – a substrate for white rot fungi during drainage of wetlands. *International Biodeterioration and Biodegradation* 50, 17–23.
Björdal, C. G., Daniel, G. and Nilsson, T. (2000) Depth of burial, an important factor in controlling bacterial decay of waterlogged archaeological poles. *International Biodeterioration and Biodegradation* 45, 15–26.
Blanchette, R. A. (2000) A review of microbial deterioration found in archaeological wood from different environments. *International Biodeterioration and Biodegradation* 46, 189–204.
Blanchette, R. A., Cease, K. R., Abad, A. R., Koestler, R. J., Simpson, E. and Sams, G. K. (1991) A review of different forms of deterioration found in archaeological wood. *International Biodeterioration and Biodegradation* 28, 3–22.
Boast, R. (1995) Fine pots, pure pots, Beaker pots. In I. A. Kinnes and G. Varndell (eds) '*Unbaked Urns of Rudely Shape': Essays on British and Irish Pottery for Ian Longworth*, 69–80. Oxbow Monograph 55. Oxford.
Booth, B. K. W., Brough, R. C. and Pryor, F. M. M. (1984) The flexible storage of site data: a microcomputer application. *Journal of Archaeological Science* 10, 81–9.
Bowman, S. and Needham, S. (2007) The Dunaverney and Little Thetford flesh-hooks: history, technology and their position within the Later Bronze Age Atlantic Zone feasting complex. *The Antiquaries Journal* 87, 53–108.
Bradley, R. and Ford, D. (2004) A long distance connection in the Bronze Age: joining fragments of a Ewart Park sword from two sites in England. In J. Bradley, J. Coles, E. Grogan, B. Raftery and H. Roche (eds), *From Megaliths to Metals: Essays in Honour of Georg Eogan*, 174–7. Oxbow Books. Oxford.
Brain, C. K. (1981) *The hunters or the hunted?: an introduction to African cave taphonomy.* University of Chicago Press. London.
Brennand, M. and Taylor, M. (2003) The survey and excavation of a Bronze Age timber circle at Holme-next-the-Sea, Norfolk, 1998–9. *Proceedings of the Prehistoric Society* 69, 1–84.
Britchfield, D. (2001) *Final report for an archaeological watching brief at Flag Fen Sewage Treatment Works, Fengate, Peterborough*. Soke Archaeological Services, Report No. SAS00/DB/15. Peterborough.
Britnell, W. J. (1976) Antler cheekpieces of the British Late Bronze Age. *The Antiquaries Journal* 56, 25–34.
Britton, D. and Longworth, I. H. (1968) *Late Bronze Age finds in the Heathery Burn Cave, Co. Durham* (*Inventaria Archaeologica* 9th set: GB.55). British Museum. London.
Brough, J. C. S. (1950) *Timber for Woodworking*. Evans Brothers, London.

Brück, J. (1995) A place for the dead: the role of human remains in Late Bronze Age Britain. *Proceedings of the Prehistoric Society* 61, 245–77.

Brück, J. (2001) Body metaphors and technologies of transformation in the English Middle and Late Bronze Age. In J. Brück (ed.), *Bronze Age Landscapes: Tradition and Transformation*, 149–60. Oxford.

Brunning, R. (1996) *Guidelines on the recording, sampling and curation of waterlogged wood*. English Heritage. London.

Brunning, R. (2007) Monuments at risk in Somerset's peatlands. In J. Barber *et al.* (eds), *Archaeology from the wetlands: recent perspectives*, 191–7. WARP/Society of Antiquaries of Scotland. Edinburgh.

Brunskill, R. W. (1985) *Timber Building in Britain*. London, Gollanz.

Bryant, J. and Froelich, P. (1995) A model of oxygen isotope fractionation in body water of large mammals. *Geochimica et Cosmochimica Acta* 59/21, 4523–37.

Buckley, D. G. and Ingle, C. J. (2001) The saddle querns from Flag Fen. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 322–9. English Heritage Archaeological Reports. London.

Buikstra, J. E. and Ubelaker, D. H. (eds) (1994) *Standards for Data Collection from Human Remains*. Proceedings of a Seminar at The Field Museum of Natural History. Arkansas Archaeology Survey Research Series No. 44. Fayetville, Arkansas.

Bulleid, A. and Gray, H. St G. (1917) *The Glastonbury Lake Village*. Glastonbury Antiquarian Society.

Caple, C. and Dungworth, D. (1998) *Waterlogged Anoxic Archaeological Burial Environments*. Ancient Monuments Laboratory Report, 22/98. English Heritage. London.

Chadwick, O. A. and Chorover, J. (2001) The chemistry of pedogenic thresholds. *Geoderma* 100, 321–53.

Chang, C. and Koster, H. (1986) Beyond bones: towards an archaeology of pastoralism, *Advances in Archaeological Method and Theory* 9, 97–148.

Chapman, H. P. and Cheetham, J. L. (2002) Monitoring and modelling maturation as a proxy indicator for in situ preservation in wetlands – a GIS-based approach. *Journal of Archaeological Science* 29 (3), 277–89.

Charman, D. (2002) *Peatlands and Environmental Change*. John Wiley and Sons. Chichester.

Choyke, A. M. (1979) A classification of the bone and antler tools from the Bronze Age hill-fortress of Pákozdvár. *Alba Regia* 17, 9–21.

Christensen, B. B. (1970) *The Conservation of Waterlogged Wood in the National Museum of Denmark*. The National Museum of Denmark. Copenhagen.

Clymo, R. S. (1983) Peat. In A. J. P. Gore (ed.), *Mires: Swamp, Bog, Fen and Moor*. Ecosystems of the world 4A, 159–224. Elsevier. Amsterdam.

Coggins, C. R. (1980) *Decay of timber buildings: Dry rot, wet rot and other fungi.* Rentokil Limited. East Grinstead.

Cohen, A. and Serjeantson, D. (1996) *A Manual for the Identification of Bird Bones from Archaeological Sites*, 2nd edition. Archetype. London.

Coles, B. J. (1995) *Wetland Management: A Survey for English Heritage*. WARP occasional paper 9. Exeter.

Coles, B. J. (2006) *Beavers in Britain's Past*. Oxbow Books. Oxford.

Coles, B. J., Coles, J. M. and Schou Jorgenson, M. (eds) (1999) *Bog bodies, Sacred Sites and Wetland Archaeology*. Wetland Archaeology Research Project. Exeter.

Coles, J. M. and Minnitt, S. (1995) *Industrious and Fairly Civilized: The Glastonbury Lake Village*. Somerset Levels Project and Somerset County Council Museums Service.

Coles, J. M. and Orme, B. J. (1978) The Meare Heath Track. In *Somerset Levels Papers* 4, 11–39.

Coles, J. M. and Orme, B. J. (1982) Beaver in the Somerset Levels: some new evidence. *Somerset Levels Papers* 8, 67–72.

Coles, J. M. and Orme, B. J. (1983) Prehistoric woodworking from the Somerset Levels: 1, Timber. *Somerset Levels Papers* 9, 19–43.

Coles, J. M., Orme, B. J. and Hibbert, F. A. (1975) The Eclipse Track. *Somerset Levels Papers* 1, 20–8.

Coles, J. M., Coles, B. J., May, J. and Moore, C. N. (1979) Excavation of Late Bronze Age or Iron Age date at Washingborough Fen. *Lincolnshire History and Archaeology* 14, 5–10.

Coombs, D. G. (2001) Metalwork. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 255–301. English Heritage Archaeological Reports. London.

Cooper, A. (2003) *Storey's Bar Road, Fengate: Archaeological Desk Based Assessment and Test Pit Survey*. Cambridge University Archaeological Unit Report No. 584. Cambridge.

Corbet, G. and Ovenden, D. (1980) *The Mammals of Britain and Europe*. Collins. Glasgow.

Corfield, M. (1993) Monitoring the condition of waterlogged archaeological sites. In P. Hoffman (ed.), *Proceedings of the 5th ICOM Group on Wet Organic Archaeological Materials Conference, Portland, Maine*, 423–36. ICOM.Bremerhaven.

Corfield, M. (1998) The role of monitoring in the assessment and management of archaeological sites. In K. Bernick (ed.), *Hidden dimensions: The Cultural Significance of Wetland Archaeology*, 302–18. UBC Press.Vancouver.

Corkhill, T. (1979) *A Glossary of Wood*. Stobart and Son Ltd. London.

Dahl, G. and Hjort, A. (1976) *Having herds: Pastoral Herd Growth and Household Economy*. University of Stockholm. Stockholm.

Darby, H. C. (1983) *The Changing Fenland*. Cambridge University Press. Cambridge.

Darling, W. (2004) Hydrological factors in the interpretation of stable isotopic proxy data present and past: a European perspective. *Quaternary Science Reviews* 23, 743–70.

Darling, W. and Talbot, J. (2003) The O and H stable isotopic composition of fresh waters in the British Isles: 1. Rainfall. *Hydrology and Earth System Sciences* 7 (2), 163–81.

Darling, W., Bath, A. and Talbot, J. (2003) The O and H stable isotopic composition of British waters in the British Isles: 2. Surface waters and groundwater. *Hydrology and Earth System Sciences* 7 (2), 183–95.

Darrah, R. (2006) Wood technology. In C. Evans and I. R. Hodder, *A Woodland Archaeology: Neolithic Sites at Haddenham*, 118–27. English Heritage.

Davey, P. J. (1973) Bronze Age metalwork from Lincolnshire. *Archaeologia* 104, 51–127.

Davidson, D. A., Wilson, C. A., Meharg, A. A., Deacon, C. and Edwards, K. J. (2007) The legacy of past manuring practices on soil contamination in remote rural areas. *Environment International* 33, 78–83.

Davis, S. (2000) The effect of castration and age on the development of the Shetland sheep skeleton and a metric comparison between bones of males, females and castrates. *Journal of Archaeological Science* 27, 373–90.

De Jong, J. (1977) Conservation techniques for old waterlogged

wood from shipwrecks found in the Netherlands. In A. Walters (ed.), *Biodeterioration investigation techniques*, 295–338. Applied Science Publishers. London.

De Mars, H. and Wassen, M. J. (1999) Redox potentials in relation to water levels in different mire types in the Netherlands and Poland. *Plant Ecology* 140, 41–51.

Desch, H. E. (1977) *Timber: Its Structure and Properties*. Macmillan. London.

Dick, W. A. and Tabatabai, M. A. (1977) An alkaline oxidation method for the determination of total phosphorus in soils. *Journal of Soil Science of America* 41, 511–14.

Donaldson, P., Kinnes, I. A. and Wells, C. (1977) The excavation of a multiple round barrow at Barnack, Cambridgeshire 1974–1976. *Antiquaries Journal* 58, 197–231.

Driesch von den, A. (1976) *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Peabody Museum Bulletin 1. Cambridge: Mass, Harvard University.

Eaton, R. A. and Hale, D. C. (1993) *Wood: Decay, pests and protection*. Chapman and Hall. London.

Entwistle, R. and Grant, A. (1989) The evidence for cereal cultivation and animal husbandry in the southern British Neolithic and Bronze Age. In A. Milles, D. Williams and N. Gardener (eds), *The Beginnings of Agriculture*, 203–15. British Archaeological Reports (International Series) S496. Oxford.

Eogan, G. (1994) *The Accomplished Art: Gold and Gold-Working in Britain and Ireland during the Bronze Age*. Oxbow Books. Oxford.

Evans, C. (1992) *Archaeological Investigations at Fengate, Peterborough: The Depot Site*. Cambridge Archaeological Unit, unpublished archive report. Cambridge.

Evans, C. (1993) The Fengate Depot site. *Fenland Research* 8, 2–9.

Evans, C. and Appleby, G. (2008) Historiography and fieldwork: Wyman Abbott's Great Fengate Ring-Ditch (a lost manuscript found). *Proceedings of the Prehistoric Society* 74, 171–92.

Evans, C. and Hodder, I. R. (2006) *A Woodland Archaeology: Neolithic Sites at Haddenham*. English Heritage. London.

Evans, C. and Pryor, F. M. M. (2001) Recent research in south Fengate. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 18–36. English Heritage Archaeological Reports. London.

Evans, C. with Taylor, M. (2006) Overview discussion: how the structure worked. In C. Evans and I. R. Hodder, *A Woodland Archaeology: Neolithic Sites at Haddenham*, 135–40. English Heritage.

Evans, C. with Beadsmoore, E., Brudenell, M. and Lucas, G. (2009) *Fengate Revisited: Further Fen-edge Excavations, Bronze Age Fieldsystems/Settlement and the Wyman Abbott/Leeds Archives*. Oxbow Books. Oxford.

Evans, J. (1881) *The ancient bronze implements, weapons, and ornaments, of Great Britain and Ireland*. Longmans, Green & Co. London.

Fell, V. (2003) The iron tools. In N. Field and M. Parker Pearson, *Fiskerton: An Iron Age Timber Causeway with Iron Age and Roman Votive Offerings*, 63–73. Oxbow Books. Oxford.

Field, N. and Parker Pearson, M. (2003) *Fiskerton: An Iron Age Timber Causeway with Iron Age and Roman Votive Offerings*. Oxbow Books. Oxford.

Fleming, A. (2008) *The Dartmoor Reaves: Investigating Prehistoric Land Divisions*, 2nd edition. Windgather Press. Oxford.

Forbes, H. (1998) European agriculture viewed bottom-side upwards: fodder and forage provisions in a traditional Greek community. *Environmental Archaeology* 1, 19–34.

French, C. A. I. (1992) Fengate to Flag Fen: summary of the soil and sediment analyses. *Antiquity* 66, 458–61.

French, C. A. I. (1997) Sewage Treatment Works, Fengate, Peterborough: preliminary soil/sediment assessment. In F. M. M. Pryor, *Archaeological Evaluation at Flag Fen Sewage Treatment Works*, Appendix 1. Soke Archaeological Services Report No. 97/2. Peterborough.

French, C. A. I. (2001) The development of the prehistoric landscape in the Flag Fen Basin. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 400–4. English Heritage Archaeological Reports. London.

French, C. A. I. (2003) *Geoarchaeology in action: Studies in Soil Micromorphology and Landscape Evolution*. Routledge. London.

French, C. A. I. (2004) Hydrological monitoring of an alluviated landscape in the Lower Great Ouse valley at Over, Cambridgeshire: results of the gravel extraction phase. *Environmental Archaeology* 9, 1–12.

French, C. A. I. (2009) Hydrological monitoring of an alluviated landscape in the Lower Great Ouse valley at Over, Cambridgeshire: the quarry restoration phase. *Environmental Archaeology* 14, 63–76.

French, C. A. I., Davis, M. and Heathcoat, J. (1999) Hydrological monitoring of an alluviated landscape in the Lower Great Ouse valley, Cambridgeshire: interim results of the first three years. *Environmental Archaeology* 4, 41–56.

French, C. A. I. and Pryor, F. M. M. (1993) *The South-West Fen Dyke Survey Project 1982–86*. East Anglian Archaeology 59. Peterborough.

French, C. A. I. and Taylor, M. (1985) Desiccation and destruction: the immediate effects of dewatering at Etton, Cambridgeshire. *Oxford Journal of Archaeology* 4 (2), 139–55.

Fricke, H. and O'Neil, J. (1996) Inter- and intra-tooth variation in the oxygen isotope composition of mammalian tooth enamel phosphate: implications for palaeoclimatological and palaeobiological research. *Palaeogeography, Palaeoclimatology, Palaeoecology* 126, 91–9.

Fricke, H., Clyde, W. and O'Neil, J. (1998) Intra-tooth variations in O_{18} isotope (PO_4) of mammalian tooth enamel as a record of seasonal variations in continental climate variables. *Geochimica and Cosmchimica Acta* 62/11, 1839–50.

Gaffney, V., Thompson, K. and Fitch, S. (2007) *Mapping Doggerland: The Mesolithic Landscapes of the Southern North Sea*. Archaeopress. Oxford.

Garton, D., Elliott, L. and Salisbury, C. (2001). Some fieldwork in Derbyshire by Trent and Peak Archaeological Unit in 1998–9: Aston-upon-Trent, Argosy Washolme (SK431291). *Derbyshire Archaeological Journal* 121, 196–200.

Gearey, B. R., Chapman, H., Howard, A., Krawiec, K., Bamforth, M., Fletcher, W., Hill, T., Marshall, P., Tetlow, E. and Tyers, I. (forthcoming) The Beccles Triple Post Alignment, Beccles Marshes, Suffolk: Excavation and Palaeoenvironmental Analyses of an Iron Age Wetland Site. *Proceedings of the Prehistoric Society* 77.

Gerloff , S. (1986) Bronze Age class A cauldrons: typology, origins and chronology. *Journal of the Royal Society of Antiquaries of Ireland* 116: 84–115.

Gibson, A. M. (1980) Beaker pottery from the Wyman Abbott collection. In F. M. M. Pryor, *Excavation at Fengate, Peterborough, England: The Third Report*, 234–45. Northamptonshire Archaeological Society Monograph 1/Royal Ontario Museum Monograph 6. Northampton and Toronto.

Gibson, A. M. (1982) *Beaker Domestic Sites: A Study of the Domestic Pottery of the Late Third and Early Second Millennia B.C. in the British Isles*, 2 vols. British Archaeological Reports British Series No. 107. Oxford.

Gibson, A. M. (1987) Beaker domestic sites across the North Sea: a review. In *Les relations entre le continent et les iles Britanniques a l'Age du Bronze*. Congrès Préhistorique de France, 1984, Actes du Colloque de Bronze de Lille, (1987), 7–16.

Gibson, A. M. (1992) Approaches to the later Neolithic and Bronze Age settlements of Britain. In C. Mordant and A. Richard (eds), *L'habitat et l'occupation du sol à l'Âge du Bronze en Europe*, 41–8. Editions du Comité des Travaux Historiques et Scientifiques. Paris,

Gibson, A. M. (1998) *Stonehenge and Timber Circles*. Tempus Books. Stroud.

Gibson, D. (1998) *Archaeological Excavations at the Co-Op Site, Fengate*. Cambridge University Archaeological Unit Report No. 264. Cambridge.

Gibson, D. and Knight, M. (2002) *Prehistoric and Roman Archaeology at Stonald Field, King's Dyke West, Whittlesey.* Cambridge University Archaeological Unit Report No. 498. Cambridge.

Gibson, D. and Knight, M. (2006) *Bradley Fen Excavations, Whittlesey, Cambridgeshire 2001–2004*. Cambridge University Archaeological Unit Report No. 733. Cambridge.

Godwin, H. (1978) *Fenland: Its Ancient Past and Uncertain Future*. Cambridge University Press. Cambridge.

Goodman, W. L. (1976) *The History of Woodworking Tools*. G. Bell and Sons. London.

Grant, A. (1982) The use of toothwear as a guide to the age of domestic ungulates. In B. Wilson, C. Grigson and S. Payne (eds), *Aging and Sexing Animal Bones from Archaeological Sites*, 91–108. British Archaeological Reports No. 109. Oxford.

Grayson, D. K. (1984) *Quantitative zooarchaeology: topics in the analysis of archaeological faunas*. Academic Press. Orlando.

Greatorix, C. (1995) *An Archaeological Evaluation at Shinewater Park, Eastbourne, East Sussex, Report on Project Number 409*. Institute of Archaeology Field Archaeology Unit, UCL. London.

Greenfield, E. (1960) The excavation of Bar Row 4 at Swarkeston, Derbyshire. *Derbyshire Archaeological Journal* 80, 1–48.

Greenwell, W. (1894) Antiquities of the Bronze Age found in the Heathery Burn Cave, County Durham. *Archaeologia* 54, 88–122.

Grigson, C. (1982) Sex and age determination of some bones and teeth of domestic cattle: a review of the literature. In B. Wilson, C. Grigson and S. Payne (eds), *Aging and Sexing of Animal Bone from Archaeological Sites*, 7–24. British Archaeological Reports No. 109. Oxford.

Gurney, D. A. (1980) Evidence of Bronze Age salt-production at Northey, Peterborough. *Northamptonshire Archaeology* 15, 1–11.

Haglund, W. D. and Sorg, M. H. (2001) *Advances in Forensic Taphonomy: Method, Theory, and Archaeological Perspectives*. CRC Press. Maine.

Haldane, A. (1973) *The Drove Roads of Scotland*. David and Charles. Newton Abbot.

Hall, D. N. (1987) *The Fenland Project, No. 2: Cambridgeshire Survey, Peterborough to March*. East Anglian Archaeology 35. Cambridge.

Hall, S. (1988) Chillingham Park and its herd of white cattle: relationships between vegetation classes and patterns of range use. *Journal of Applied Ecology* 25, 777–89.

Halliday, T. M. (1986) A note on the Flag Fen site and its recent history. In F. M. M. Pryor, C. A. I. French and M. Taylor, Flag Fen, Fengate, Peterborough I: discovery, reconnaissance and initial excavation. *Proceedings of the Prehistoric Society* 52, 1–24, at 2.

Halstead, P. (1985) A study of mandibular teeth from Romano-British contexts at Maxey. In F. M. M. Pryor, C. A. I. French, D. Crowther, D. A. Gurney, W. G Simpson. and M. Taylor, *The Fenland Project No. 1: Archaeology and Environment in the Lower Welland Valley*, volume 1, 219–24. East Anglian Archaeology 27. Cambridge.

Halstead, P. (1998a) Ask the fellow who lops the hay: leaf-fodder in the mountains of north-west Greece. *Rural History* 9/2, 211–34.

Halstead, P. (1998b) Mortality models and milking: problems of uniformitarianism, optimality and equifinality reconsidered. *Anthropozoologica* 27, 3–20.

Halstead, P. and Cameron, E. (1992) Bone remains from Flag Fen Platform and Fengate Power Station post alignment. *Antiquity* 66, 499–501.

Halstead, P., Cameron, E. and Forbes, S. (2001) Non-human and human mammalian bone remains from the Flag Fen Platform and Power Station alignment. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 330–402. English Heritage Archaeological Reports. London.

Hawkes, C. F. C. and Fell, C. I. (1945) The early Iron Age settlement at Fengate, Peterborough. *Archaeological Journal* 100, 188–223.

Hayen, H. (1987) Peatbog archaeology in Lower Saxony, West Germany. In J. M. Coles and A. J. Lawson (eds), *European Wetlands in Prehistory*, 117–36. Clarendon Press. Oxford.

Head, J. F. (1938) The excavation of the Cop round barrow, Bledlow. *Records of Buckinghamshire* 13, 313–51.

Heslop, D. H. (2008) *Patterns of Quern Production, Acquisition and Deposition: A Corpus of Beehive Querns from Northern Yorkshire and Southern Durham*. Yorkshire Archaeological Society. York.

Hey, G. (in prep.) *Yarnton: Neolithic and Bronze Age Settlement And Landscapes. Results of Excavations 1989–1998*. Thames Valley Landscapes Monograph, Oxford Archaeology. Oxford.

Hillson, S. (1990) *Teeth*. Cambridge Manuals in Archaeology. Cambridge University Press. Cambridge.

Hillson, S. (1992) *Mammal Bones and Teeth: An Introductory Guide to Methods of Identification*. Dorset Press. Dorchester.

Holden, J., Jared-West, L., Howard, A. J., Maxfield, E., Panter, I. and Oxley, J. (2006) Hydrological controls of in situ preservation of waterlogged archaeological deposits. *Earth Science Reviews* 78, 59–83.

Horton, A., Lake, R. D., Bisson, G. and Coppack, B. C. (1974) *The Geology of Peterborough*. Report of the Institute of Geological Sciences, 73/12. London.

Hutchinson, J. (1980) The record of peat wastage in the East Anglian fenlands at Holme Post, 1848–1978 AD. *Journal of Ecology* 68, 229–49.

Iacumin, P., Bocherens, H., Mariotti, A. and Longinelli, A. (1996) Oxygen isotope analyses of co-existing carbonate and phosphate in biogenic apatite: a way to monitor diagenetic alteration of bone phosphate? *Earth and Planetary Science Letters* 142, 1–6.

Ingram, H. A. P. (1978) Soil layers in mires: function and terminology. *Journal of Soil Science* 29, 224–7.

Ingram, H. A. P. (1992) Introduction to the ecohydrology of mires in the context of cultural perturbation. In O. Bragg, P. Hulme, H. Ingram and R. Robertson (eds), *Peatland Ecosystems and Man: An Impact Assessment*, 67–93. Department of Biological Sciences, University of Dundee in association with the International Peat Society. Dundee.

IPCC (Intergovernmental Panel on Climate Change) (2007) *Climate Change 2007 – The Physical Science Basis, Working Group I Contribution to the Fourth Assessment Report of the IPCC*. Cambridge University Press. Cambridge.

Jekyll, G. (1899) *Wood and Garden*. Longmans, Green and Co. London.

Jones, J., Tinsley, J. and Brunning, R. (2007) Methodologies for assessment of the state of preservation of pollen and plant macrofossil remains in waterlogged deposits. *Environmental Archaeology* 12 (1), 71–86.

Jordan, B. A. (2001) Site characteristics impacting the survival of historic waterlogged wood: a review. *International Biodeterioration and Biodegradation* 47, 47–54.

Kaye, B. (1995) Conservation of waterlogged archaeological wood. *Chemical Society Reviews* 24 (1), 35–43.

Keswani, P. (1994) The social context of animal husbandry in early agricultural societies: ethnographic insights and an archaeological example from Cyprus. *Journal of Anthropological Archaeology* 13, 255–77.

Key, C., Aiello, L. C. and Molleson, T. (1994) Cranial suture closure and its implications for age estimation. *International Journal of Osteoarchaeology* 4, 193–207.

Klein, R., Wolf, C., Freeman, L. and Allwarden, K. (1981) The use of dental crown heights for constructing age profiles of red deer and similar species in archaeological samples. *Journal of Archaeological Science* 8, 1–31.

Kohn, M., Schoeninger, M. and Valley, J. (1998) Variability in oxygen isotope composition of herbivore teeth: reflections of seasonality or developmental physiology? *Chemical Geology* 152, 97–112.

Lawrence, G. F. (1929) Antiquities from the middle Thames. *Archaeological Journal* 85, 175–86.

Lawson, A. J. (1994) Potterne. In A. Fitzpatrick and E. Morris (eds), *The Iron Age in Wessex: Recent Work*, 42–6. Trust for Wessex Archaeology. Salisbury.

Lawson, A. J. (2000) *Potterne 1982–5: Animal Husbandry in Later Prehistoric Wiltshire*. Wessex Archaeology Report 17. Salisbury.

Leeds, E. T. (1922) Further discoveries of the Neolithic and Bronze Ages at Peterborough. *Antiquaries Journal* 2, 220–37.

Legge, A. (1981) The agricultural economy. In R. Mercer (ed.), *Grimes Graves, Norfolk: Excavations 1971–72: Volume 1*, 79–103. London, HMSO.

Legge, A. (1989) Milking the evidence: a reply to Entwistle and Grant. In A. Milles, D. Williams and N. Gardener (eds), *The Beginnings of Agriculture*, 217–42. British Archaeological Reports (International Series) S496. Oxford.

Lillie, M. (2007) In situ preservation: geo-archaeological perspectives on an archaeological Nirvana. In M. Lillie and S. Ellis (eds), *Wetland Archaeology and Environments: Regional Issues, Global Perspectives*, 173–85. Oxbow Books. Oxford.

Lillie, M. and Cheetham, J. (2002) *Water Table Monitoring at Flag Fen, Peterborough*. Wetland Archaeology and Environments Research Centre, University of Hull Report No. SAS-FF/02–01.

Longley, D. (1980) *Runnymede Bridge 1976: Excavations on the Site of a Late Bronze Age Settlement*. Research Volume of the Surrey Archaeological Society No. 6. Guildford.

Louwe-Kooijmans, L. P. (1974) *The Rhine/Meuse Delta: Four Studies on its Prehistoric Occupation and Holocene Geology*. Oudheidkundige Mededelingen. Leiden.

Lucas, A. (1989) *Cattle in Ancient Ireland*. Boethius Press. Kilkenny.

Lucas, G. (1997) *An Archaeological Evaluation at the Tower Works, Fengate, Peterborough*. Cambridge University Archaeological Unit Report No. 206. Cambridge.

MacCormack, C. (1981) Exchange and hierarchy. In A. Sheridan and G. Bailey (eds) *Economic Archaeology*, 159–66. British Archaeological Reports (International Series) 96. Oxford.

McGrail, S. (1978) *Logboats of England and Wales*, 2 vols. British Archaeological Reports British Series 1 (i). Oxford.

Mainland, I. (1998a) The lamb's last supper: the role of dental microwear analysis in reconstructing livestock diet in the past. *Environmental Archaeology* 1, 55–62.

Mainland, I. (1998b) Dental microwear and diet in domestic sheep (*Ovis aries*) and goats (*Capra hircus*): distinguishing grazing and fodder-fed ovicaprids using a quantitative analytical approach. *Journal of Archaeological Science* 25, 1259–71.

Mainland, I. (2000) A dental microwear study of seaweed-eating and grazing sheep from Orkney. *International Journal of Osteoarchaeology* 10, 93–107.

Mainland, I. (2001) The potential of dental microwear for exploring seasonal aspects of sheep husbandry and management in Norse Greenland. *Archaeozoologia* 11, 79–100.

Mainland, I. (2003) Dental microwear in grazing and browsing Gotland sheep (*Ovis aries*) and its implications for dietary reconstruction. *Journal of Archaeological Science* 30, 1513–27.

Mainland, I. and Halstead, P. (2002) The diet and management of sheep and goats at Neolithic Makriyalos. In J. Davies, M. Fabis, I. Mainland, M. Richard and R. Thomas (eds), *Diet and Health in Past Animal Populations*, 104–12. Proceedings of the 9th Conference ICAZ, Durham. Oxbow Books. Oxford.

Mashkour, M., Bocherens, H. and Moussa, I. (2002) Long distance movement of sheep and goats of Bakhtiari nomads tracked with intra-tooth variations of stable isotopes (13C and 18O). In J. Davies and M. Fabis (eds), *Diet and Health in Past Animal Populations*, 113–24. Proceedings of the 9th Conference ICAZ, Durham. Oxbow Books. Oxford.

Mays, S. and Cox, M. (2000) Sex Determination in Skeletal Remains. In M. Cox and S. Mays (eds), *Human Osteology In Archaeology and Forensic Science*, 117–30. Greenwich Medical Media Ltd. London.

McKern, T. W. and Stewart, T. D. (1957) *Skeletal Age Changes in Young American Males*. Quartermaster research and Development Command Technical Report WP-45. Nateick, MA.

Meadows, I. (2007) *An Archaeological Evaluation on Land off Storeys Bar Road Peterborough, Cambridgeshire, October 2007*. Northamptonshire Archaeology Report No. 07/159.

Miller, S. H. and Skertchly, S. B. J. (1878) *The Fenland Past and Present*. Longmans. London.

Molleson, T. and Cox, M. (1993) *The Spitalfields Project Volume 2: The Anthropology – The Middling Sort*. CBA Research Report 86. Council for British Archaeology. York.

Moore, J. and Jennings, D. (1992) *Reading Business Park: A Bronze Age Landscape.* Oxford University Committee for Archaeology. Oxford.

Morgan, R. (1979) Tree-ring studies in the Somerset Levels: The drove site of the Sweet Track. *Somerset Levels Papers* 5, 65–74.

Morgan, R. (2006) Structural timbers and roundwood. In C. Evans and I. R. Hodder, *A Woodland Archaeology: Neolithic Sites at Haddenham*, 104–18. English Heritage.

Mortimer, J. R. (1905) *Forty Years' Researches in British and Saxon Burial Mounds of East Yorkshire*. A. Brown and Sons. London, Hull and York.

Mudd, A. and Pears, B. (2008) *Bronze Age Field System at Tower's Fen, Thorney, Peterborough: Excavations at 'Thorney Borrow Pit' 2004–2005.* British Archaeological Reports (British Series) 471. Oxford.

Murphy, J. and Riley, J. P. (1962) A modified single solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta* 27, 31–6.

Needham, S. P. (1991) *Excavation and Salvage at Runnymede Bridge, 1978: The Late Bronze Age Waterfront Site*. British Museum Press. London.

Needham, S. (1992) The structure of settlement and ritual in the Late Bronze Age of south-east Britain. In C. Mordant and A. Richard (eds), *L'habitat et l'occupation du sol à l'Âge du Bronze en Europe*, 49–69. Editions du Comité des Travaux Historiques et Scientifiques. Paris.

Needham, S. P. and Rohl, B. (1998) *The Circulation of Metal in the British Bronze Age: The Application of Lead Isotope Analysis*. British Museum Occasional Paper No. 102. London.

Needham, S. P. and Sørensen, M. L. S. (1988) Runnymede refuse tip: a consideration of midden deposits and their formation. In J. C. Barrett and I. A. Kinnes (eds), *The Archaeology of Context in the Neolithic and Bronze Age: Recent Trends*, 113–26. University of Sheffield. Sheffield.

Needham, S. P. and Spence, T. (1996) *Refuse and disposal at Area 16 East, Runnymede*. Trustees of the British Museum. London.

Nord, A. G., Tronner, K. and Ullén, I. (2002) On the deterioration of archaeological iron artefacts in soil. *Fornvännen* 97, 298–300.

Nord, A. G., Mattsson, E. and Tronner, K. (2005a) Factors influencing the long-term corrosion of bronze artefacts in the soil. *Protection of Metals* 41, 309–16.

Nord, A. G., Tronner, K., Mattsson, E., Borg, G. C. and Ullén, I. (2005b) Environmental threats to buried archaeological remains. *Ambio* 34 (3), 256–62.

Norfolk Museums Service (1977) *Bronze Age Metalwork in Norwich Castle Museum*, 2nd edition. Norwich.

O'Connor, B. (1980) *Cross-Channel Relations in the British Later Bronze Age*. British Archaeological Reports International Series, S91. Oxford.

Ortner, D. J. and Putschar, W. G. J. (1985) *Identification of Pathological Conditions in Human Skeletal Remains*. Smithsonian Contributions to Anthropology Number 28. Smithsonian Institute Press. Washington DC.

O'Sullivan A. (1991) *The evidence for excavated trackways in the raised bogs of Co-Longford.* Unpublished MA thesis, University College Dublin. Cited in Sands, R. (1997) *Prehistoric woodworking: the analysis and interpretation of Bronze and Iron Age toolmarks.* Institute of Archaeology, University College. London.

Palmer, R. (1999) *Fengate to Northey Area TL2098 to TF2400, Cambridgeshire: Interpretation of Aerial Photographs*. Air Photo Services Ltd. Report 1999/02. Cambridge.

Patten, R. (2003) *The Flag Fen Sewage Works, Fengate, Peterborough. A Watching Brief.* Cambridge University Archaeological Unit Report No. 555. Cambridge.

Payne, S. (1973) Kill-off patterns in sheep and goats: the mandibles from Asvan Kale. *Anatolian Studies* 23, 281–303.

Pollard, A. M., Wilson, L., Wilson, A. S., Hall, A. J. and Shiel, R. (2004) Assessing the influence of agrochemicals on the rate of copper corrosion in the vadose zone of able land. *Conservation and Management of Archaeological Sites* 6, 363–76.

Powell, K. (1999) *The impact of recent changes within the subsurface environment upon the integrity of buried wood: implications for the in situ preservation of archaeological timbers*. Unpublished PhD thesis, University of Surrey.

Powell, K., Pedley, S., Daniel, G. and Corfield, M. (2001) Ultrastructural observations of microbial succession and decay of wood buried at a Bronze Age archaeological site. *International Biodeterioration and Biodegradation* 47, 165–73.

Pryor, F. M. M. (1974) *Excavation at Fengate, Peterborough, England: The First Report*. Royal Ontario Museum Archaeological Monograph 3. Toronto.

Pryor, F. M. M. (1978) *Excavation at Fengate, Peterborough, England: The Second Report*. Royal Ontario Museum Archaeological Monograph 5. Toronto.

Pryor, F. M. M. (1980) *Excavation at Fengate, Peterborough, England: The Third Report*. Northamptonshire Archaeological Society Monograph 1/Royal Ontario Museum Monograph 6. Northampton and Toronto.

Pryor, F. M. M. (1984) *Excavation at Fengate, Peterborough, England: The Fourth Report*. Northamptonshire Archaeological Society Monograph 2/Royal Ontario Museum Monograph 7. Northampton and Toronto.

Pryor, F. M. M. (1988) Earlier Neolithic organised landscapes and ceremonial in lowland Britain. In I. A. Kinnes and J. Barrett (eds), *The Archaeology of Context in the Neolithic and Bronze Age: Recent Trends*, 63–72. University of Sheffield. Sheffield.

Pryor, F. M. M. (1991) *The English Heritage book of Flag Fen: Prehistoric Fenland Centre*. London.

Pryor, F. M. M. (1992) Introduction to current research at Flag Fen, Peterborough. *Antiquity* 66, 439–57.

Pryor, F. M. M. (1993) Excavations at Site 11, Fengate, Peterborough, 1969. In W. G. Simpson, D. A. Gurney, J. Neeve and F. M. M. Pryor, *The Fenland Project No 7: excavations in Peterborough and the lower Welland Valley, 1960–69*, 127–40. East Anglian Archaeology Report 61. Norwich.

Pryor, F. M. M. (1996) Sheep, stockyards and field systems: Bronze Age livestock populations in the fenlands of eastern England. *Antiquity* 70, 313–24.

Pryor, F. M. M. (1997a) *Archaeological Evaluation at Murden's Former Depot, Fengate, Peterborough*. Fenland Archaeological Trust Report 97/1. Peterborough.

Pryor, F. M. M. (1997b) *Peterborough East: A Guide to Curation in an Area of Outstanding Archaeological Importance*. Unpublished report. Fenland Archaeological Trust. Peterborough.

Pryor, F. M. M. (1997c) *Archaeological Evaluation at Flag Fen Sewage Treatment Works*. Soke Archaeological Services Report No. 97/2. Peterborough.

Pryor, F. M. M. (1998a) *Farmers in Prehistoric Britain*. Tempus Books. Stroud.

Pryor, F. M. M. (1998b) Welland Bank Quarry, South Lincolnshire. *Current Archaeology* 160, 139–45.

Pryor, F. M. M. (2000a) *A Report on Archaeological Excavations at Boroughby Garage Ltd., Storey's Bar Road, Peterborough (TL 2167 9941)*. Unpublished report SAS 00/1. Soke Archaeological Services. Peterborough.

Pryor, F. M. M. (2000b) *Flag Fen Fire Damage Assessment Report*, Unpublished Archive Report for Fenland Archaeological Trust. English Heritage project number 2781.

Pryor, F. M. M. (2001) *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*. English Heritage Archaeological Reports. London.

Pryor, F. M. M. (2003) *Britain BC: Life in Britain and Ireland Before the Romans*. Harper Collins. London.

Pryor, F. M. M. (2005) *Flag Fen: Life and Death of a Prehistoric Landscape*. Tempus Books. Stroud.

Pryor, F. M. M. and Taylor, M. (1993) Use, re-use or pre-use? Aspects of the interpretation of ancient wood. In J. M. Coles, V. Fenwick and G. Hutchinson (eds), *A Spirit of Enquiry: Essays for Ted Wright*, 81–4. WARP. Exeter.

Pryor, F. M. M., French, C. A. I., Crowther, D., Gurney, D. A., Simpson, W. G. and Taylor, M. (1985) *The Fenland Project No. 1: Archaeology and Environment in the Lower Welland Valley*, volume 1. East Anglian Archaeology 27. Cambridge.

Pryor, F. M. M., French, C. A. I. and Taylor, M. (1986) Flag Fen, Fengate, Peterborough I: discovery, reconnaissance and initial excavation. *Proceedings of the Prehistoric Society* 52, 1–24.

Pryor, F. M. M., Taylor, M. and Britchfield, D. (2001) *Archaeological Investigations in Advance of Works Associated with the Green Wheel Cycleway at Flag Fen and Northey, Peterborough (1998–2001)*. Unpublished report SAS01/30. Soke Archaeological Services. Peterborough.

Rackham, O. (1977) *Neolithic woodland management in the Somerset Levels: Garvin's. Walton Heath and Rowland's tracks.* Somerset Levels Papers 3, 65–71.

Rankine, W. F. (1956) Hour glass perforated pebbles and cupped pebbles: Appendix C. In W. F. Rankine, *The Mesolithic of Southern England*, Research Paper of the Surrey Archaeological Society No. 4. Guildford.

RCHM (1969) *Peterborough New Town: A Survey of the Antiquities in the Areas of Development*. Royal Commission on Historical Monuments. HMSO London.

Riddler, I. (2008) Objects of bone and antler. In R. Patten, *Excavations at Eye Quarry: The Southern Extention, Phases 1, 2 and 3*. Cambridge University Archaeological Unit Report No. 869. Cambridge.

Roes, A. (1963) *Bone and Antler Objects from the Frisian Terp-mounds*. H. D. Tjeenk Willink & Zoon N. V. Haarlem.

Rowell, R. M. and Barbour, R. J. (eds) (1990) *Archaeological Wood Properties, Chemistry and Preservation*. Advances in Chemistry series 225. American Chemical Society. Washington DC.

Rowlands, M. (1980) Kinship, alliance and exchange in the European Bronze Age. In J. Barrett and R. Bradley (eds), *Settlement and Society in the British Later Bronze Age, Part 1*, 15–56. British Archaeological Reports (British Series) 83i. Oxford.

Russell, K. (1988) *After Eden*. British Archaeological Reports (International Series) 391. Oxford.

Sands, R. (1997) *Prehistoric woodworking: the analysis and interpretation of Bronze and Iron Age toolmarks.* Institute of Archaeology, University College. London.

Scaife, R. (1992) Flag Fen: The vegetation environment. *Antiquity* 66, 462–6.

Scaife, R. (2001) The vegetation and environment. In F. M. M. Pryor *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 351–81. English Heritage Archaeological Reports. London.

Schmid, E. (1972) *Atlas of Animal Bones*. Amsterdam, Elsevier.

Schmidt, P. K. and Burgess, C. B. (1981) *The Axes of Scotland and Northern England*. Prathistorische Bronzefunde Bd 7 Abteilung 9. C. H. Beck'sche Verlagsbuchhandlung. Munich.

Seager Smith, R. H. (2000) Worked bone and antler. In A. L. Lawson *Potterne 1982–5: Animal Husbandry in Later Prehistoric Wiltshire*, 222–40. Wessex Archaeology Report No. 17. Salisbury.

Sealey, J., Armstrong, R. and Schrire, C. (1995) Beyond lifetime averages: tracing life histories through isotopic analysis of different calcified tissues from archaeological human skeletons. *Antiquity* 69, 290–300.

Shennan, I. (1982) Problems of correlating Flandrian sea-level changes and climate, in A. F. Harding (ed.) *Climate Change in Later Prehistory*, 52–67. Edinburgh.

Sheppard, T. (1941) The Parc-y-Meirch hoard, St George parish, Denbighshire. *Archaeologia Cambrensis* 96, 1–10.

Sheridan, J. A. and Davis, M. (1998) The Welsh 'jet set' in prehistory: a case of keeping up with the Joneses? In A. M. Gibson and D. D. A. Simpson (eds), *Prehistoric Ritual and Religion: Essays in Honour of Aubrey Burl*, 148–62. Sutton. Stroud.

Sheridan, J. A. and Davis, M. (2002) Investigating jet and jet-like artefacts from prehistoric Scotland: the National Museums of Scotland project. *Antiquity* 76, 812–25.

Silver, I. (1969) The ageing of domestic animals: a survey of progress and research. In D. Brothwell and E. Higgs (eds), *Science in Archaeology*, 2nd edition, 283–302. Thames and Hudson. London.

Simpson, D. D. A. (1971) Beaker houses and settlements in Britain. In D. D. A. Simpson (ed.) *Economy and Settlement in Neolithic and Early Bronze Age Britain and Europe*, 131–52. Leicester University Press. Leicester.

Simpson, W. G., Gurney, D. A., Neeve, J. and Pryor F. M. M. (1993) *The Fenland Project No 7: excavations in Peterborough and the lower Welland Valley, 1960–69,* East Anglian Archaeology Report 61. Norwich.

Smart, P. (2008) Hydrology, flood risk and soils. *In Peterborough Environmental Park Environmental Impact Assessment*, Peterborough Renewable Energy Limited (PREL), 362–81. PREL. Peterborough.

Solounias, N. and Moelleken, S. (1992) Toothwear microwear analysis of *Eotragus sansaniensis* (Mammalia: Ruminantia), one of the oldest known bovids. *Journal of Vertebrate Palaeontology* 12 (1), 113–21.

Spänhoff, B., Alecke, C. and Meyer, E. I. (2001) Simple method for rating the decay stages of submerged woody debris. *Journal of the North American Benthological Society* 20 (3), 385–94.

SSEW (1983) *Soils of England and Wales: sheet 4: Eastern England (1:250,000)*. Soil Survey of England and Wales. Harpenden.

St George Gray, H. (1917) Objects of Iron. In A. Bulleid and H. St George Gray (eds), *The Glastonbury lake village. A full description of the excavations and the relics discovered*, 1892–1907 volume 2. The Glastonbury Antiquarian Society. Glastonbury.

Stead, I. M. (2006) *British Iron Age Swords and Scabbards*. British Museum Press. London.

Stone, J. F. S. (1933) Excavations at Easton Down, Winterslow, 1931–1932. *Wiltshire Archaeological Magazine* 46, 225–42.

Summers, D. (1976) *The Great Level: A History of Drainage and Land Reclamation in the Fens*. London, David and Charles.

Taylor, M. (1981) *Wood in Archaeology*. Shire Publications. Princes Risborough.

Taylor, M. (1998) Wood and bark from the enclosure ditch. In F. M. M. Pryor *Etton: Excavations at a Neolithic Causewayed Enclosure near Maxey Cambridgeshire, 1982–7*, 115–59. English Heritage Archaeological Report 18. London.

Taylor, M. (2001) The wood. In F. M. M. Pryor, *The Flag Fen Basin: Archaeology and Environment of a Fenland Landscape*, 167–228. English Heritage Archaeological Reports. London.

Taylor, M. (2003) The wood. In N. Field and M. Parker Pearson, *Fiskerton: An Iron Age Timber Causeway with Iron Age and Roman Votive Offerings, the 1981 Excavations*, 38–48. Oxbow Books. Oxford.

Taylor, M. (2009a) The Waterlogged Wood. In P. Daniel, *Archaeological Excavations at Pode Hole Quarry: Bronze Age occupation on the Cambridgeshire Fen-edge*. British Archaeological Reports (British Series) 484. Oxford.

Taylor, M. (2009b) The wood. In J. Rylatt, *Excavations at Fiskerton, 2001*.

Taylor, R., Cronin, A., Pedley, S., Barker, J. and Atkinson, T. (2004) The implications of groundwater velocity variations on microbial transport and wellhead protection – review of field of evidence. *FEMS Microbial Ecology* 49, 17–26.

Therkorn, L. L., Brandt, R. W., Pals, J. P. and Taylor, M. (1984) An Early Iron Age farmstead: Site Q of the Assendelver Polders Project. *Proceedings of the Prehistoric Society* 50, 351–73.

Thomas, R., Robinson, M., Barrett, J. and Wilson, B. (1986) A Late Bronze Age riverside settlement at Wallingford, Oxfordshire. *Archaeological Journal* 143, 174–200.

Tilley, C. (1994) *A Phenomenology of Landscape: Places, Paths and Monuments*. Berg. Oxford.

Tronner, K., Nord, A. G. and Borg, G. C. (1995) Corrosion of archaeological bronze artefacts in acidic soil. *Water, Air, and Soil Pollution* 85 (4), 2725–30.

Ungar, P. (2002) *Microwear image analysis software*. Version 4.02 (04.10.2002) Buffalo Edition.

Van de Noort, R., Ellis, S., Taylor, M. and Weir, D. (1995) Preservation of archaeological sites. In R. Van de Noort and S. Ellis (eds), *Wetland Heritage of Holderness: An Archaeological Survey*. Humber Wetlands Project. Hull.

Van Heeringen, R. M. and Theunissen, L. (2001) Repeated water table lowering in the Dutch Delta: a major challenge to the archaeological heritage management of pre- and protohistoric wetlands. In B. Purdy (ed.), *Enduring Records: The Environmental and Cultural Heritage of Wetlands*, 271–6. Oxbow Books. Oxford.

Van Heeringen, R. M. and Theunissen, L. (2002) *Desiccation of the Archaeological Landscape at Voorne-Putten*. Nederlandse Archeologische Rapporten 25, Rijksdienst voor het Oudheidkundrig Bodemonderzoek. Amersfoort.

Vaughan, T. and Trevarthen, M. (1998) *Land off Vicarage Farm Road, Peterborough, Cambridgeshire: Archaeological Evaluation (NGR TL 2170 9960)*. Hertfordshire Archaeological Trust Report 392.

Waller, M. (1994) *The Fenland Project, No 9: Flandrian Environmental Change in Fenland*. East Anglian Archaeology 70. Cambridge.

Walters, G. (2001) Threats and pressures on wetland environments in England and Wales and the response of the Environment Agency. In B. J. Coles and A. Oliver *The Heritage Management of Wetlands in Europe*, 17–22. WARP and EAC. Exeter and Brussels.

Watts, S., Pollard, A. M. and Wolff, G. A. (1997) Kimmeridge jet – a potential new source for British jet. *Archaeometry* 39 (1), 125–43.

Webley, L. (2004) *Middle Bronze Age finds at Langtoft Common, Lincolnshire: An Archaeological Watching Brief*. Cambridge Archaeological Unit Report No. 656. Cambridge.

White, T. D. (2000) *Human Osteology*, 2nd edition. Academic Press. San Diego, CA and London.

Wilson, K. and White, D. J. B. (1986) *The Anatomy of Wood*. Stobart. London.

Woodcock, A. (1998) A late Bronze Age site at Shinewater Park, near Eastbourne. *Proximus* 2, 11–16.

Yates, D. T. (2007) *Land, Power and Prestige: Bronze Age Field Systems in Southern England*. Oxbow Books. Oxford.